ANNUAL REPORT

From the Navy Department
Dec. 17. 189

OF THE

CRETARY OF THE NAVY

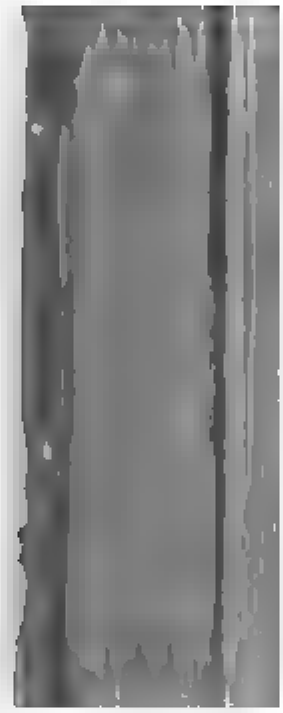
FOR

THE YEAR 1885.

IN TWO VOLUMES.

VOLUME I.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1885.



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REPORT

OF THE

SECRETARY OF THE NAVY.

WASHINGTON, D. C.,
NAVY DEPARTMENT,
November 30, 1885.

TO THE PRESIDENT:

SIR: I have the honor to lay before you the regular annual report of the Navy Department for the fiscal year ending June 30, 1885:

WAR VESSELS IN COMMISSION.

The North Atlantic squadron remains under the command of Acting Rear-Admiral James E. Jouett. The Brooklyn was put in commission on October 15, at the Brooklyn navy-yard, and now forms a part of this squadron. A serious revolution, threatening the transit of the Isthmus of Panama, having occurred on the isthmus early in the spring, a force of about 600 blue-jackets and marines, under the command of Commander B. H. McCalla, was sent thither in April, to act under the orders of Acting Rear-Admiral Jouett in keeping the transit open and in maintaining treaty obligations. This force was withdrawn in May, when the necessity for its presence no longer existed, one or more vessels remaining in Colombian waters until the month of July. The vessels of the North Atlantic squadron at present are the Tennessee (flagship), Brooklyn, Galena, Swatara, Alliance, and Yantic.

The South Atlantic squadron was re-enforced by the arrival of Rear-Admiral Earl English in his flagship, the Lancaster, at Rio de Janeiro on July 1. This officer assumed command immediately upon his arrival. The only other vessel on this station is the Nipsic. Because of several complaints recently forwarded by the Department of State from American citizens residing in the Comoro Islands and in Zanzibar, the Lancaster has been ordered to make an extended cruise in the neighborhood of these places, with a view to the satisfactory settlement of the differences which have occurred or may occur.

Acting Rear-Admiral John L. Davis is still in command of the Asiatic station. The Enterprise has been ordered to proceed home by way of Australia and Cape Horn, running a line of soundings across the Pa-

cific Ocean, and the Juniata to proceed home by way of the Cape of Good Hope, touching at Zanzibar and the Comoro Islands, in view of the difficulties at those places already referred to. Each of these vessels will have been slightly over three years away from the United States by the time her orders are executed. The Asiatic station has been re-enforced by the Omaha and Marion, so that it now consists of the Trenton (flagship), Omaha, Marion, Ossipee, Alert, Monocacy, and Palos.

The Pacific squadron was, until May 28, under the command of Rear-Admiral John H. Upshur. On this day Rear-Admiral E. Y. McCauley assumed command at San Francisco. Of this squadron the Lackawanna and Wachusett have gone out of commission during the year, it having been reinforced by the reporting of the Mohican and Adams. The Shenandoah, Iroquois, and Wachusett, of this squadron, assisted in maintaining treaty obligations in the insurrection on the Isthmus of Panama in the spring. The squadron now consists of the Hartford (flag-ship), Shenandoah, Mohican, Iroquois, Adams, and Pinta. The latter vessel is occupied exclusively in cruising in Alaskan waters.

The command of the European squadron was relinquished by Rear-Admiral English at the Congo River on May 2, 1885, and was assumed by Rear-Admiral Samuel R. Franklin, in his flag-ship Pensacola, at Gibraltar, on June 18. The squadron now consists of the Pensacola, Quinnebaug, and Kearsarge.

The vessels of the Navy on detached service are the Powhatan and Despatch on the Atlantic coast, the Michigan on the lakes, and the Ranger in surveying and sounding work on the coast of California.

BUREAU OF YARDS AND DOCKS.

The Chief of the Bureau of Yards and Docks, Commodore D. B. Harmony, reports on the condition of the navy-yards, docks, wharves, buildings, and other property in charge of the Bureau, with recommendations as to the most pressing improvements required.

It appears from his report that this property, aggregating in value some fifty millions of dollars, is falling rapidly into a condition of extreme decay. The reports from the yards make frequent complaint of buildings falling or about to fall; roofs leaking to such an extent as to involve the destruction of property stored underneath; wharves so rotten that persons cannot walk over them in safety; stone dry-docks which are required to be shored up with timber; bad roadways, defective water-pipes, and in general such an extent of decay and dilapidation as to imply a general destruction.

If it is the policy of Congress to maintain the navy-yards as ship-yards, workshops, or depots of supply, it is manifest that the work of putting the buildings, wharves, and other appurtenances in proper repair should be undertaken at once and should be kept up from year

to year, as the only alternative must be the abandonment of all the property to waste and ruin.

Attention is called to the special improvements recommended by the Bureau at the several yards, and the importance of beginning these improvements is commended to the consideration of Congress. It is especially desirable that such dry-docks should be constructed at the several yards as will give adequate facilities for docking the vessels of the Navy.

The League Island yard is now practically closed. In case Congress should decide to reopen the yard, an estimate of $232,000 is presented for necessary improvements. To make the plant now in the yard available for the repairs of ships, a Simpson dry-dock will be a necessity. Such a dock will cost about $700,000, and will require two years to complete.

BUREAU OF EQUIPMENT AND RECRUITING.

The report of the Chief of the Bureau of Equipment and Recruiting, Commodore Winfield S. Schley, describes in detail the operations of the Bureau in the purchase, manufacture, and supply of coal, sails, hemp, cordage, chains, anchors, galleys, and other articles of equipment under its charge. Tables are presented showing the superiority in strength of the rope manufactured at the rope-walk in the Boston navy yard over that furnished by private dealers.

The Bureau strongly recommends the acquisition of a modern plant for the rolling mill, chain shop, and forge and anchor shop at the Washington navy-yard. The plant has undergone no improvement for twenty-five years, and it is believed that the expenditure necessary to defray the cost of its renewal would in a short time be more than covered by the increased efficiency of the establishment. Legislation is also recommended looking to the compulsory inspection and test of anchors and chains intended for the Navy and mercantile marine, which could be conducted by naval officers with no additional expense to the Government or to private parties, and which would add greatly to the security of navigation.

The number of apprentices received in the Navy during the past year was 759. The cruising training ships have been kept at sea as much as possible, making two cruises, each of several months' duration, to the West Indies and to Europe. In view of the antiquated type of these vessels, and the fact that they will shortly become unseaworthy, it is recommended that two composite vessels be constructed of modern type, embodying the latest improvements in engines, guns, and torpedo apparatus, for use in the training service.

The average number of seamen and apprentices has not exceeded the legal quota. The cost of maintaining the 409 men allowed to the Coast Survey and the Fish Commission is about $332,428. These men should provided for independently of the quota for the Navy, as it cannot

certainly be the intention of Congress that such a heavy drain upon the naval appropriation should be made for the support of outside services. Certain other changes in the legislation in regard to enlisted men are urgently needed. A comparison of the statutes relating to enlisted men in the Army and Navy shows that the latter service is placed in many ways at a great disadvantage. Honorably discharged men should be allowed to elect a home on board receiving-ships during the three months allowed by law to re-enlist. The statute relating to the admission to citizenship of aliens enlisted in the Army should be extended to cover naval enlistments, and authority should be given to commissioned officers of the Navy to administer the oath of allegiance to the men. The recruit, upon enlistment, should receive his clothing outfit from the Government, instead of becoming, as at present, a debtor to the Government to the amount of three months' pay. Appropriation should be made for the purchase of reading matter for the crews. Provision should be made for the retirement of seamen after thirty years of service, as is now done in the Army and Marine Corps. Finally, the savings-bank system, introduced in the Army by statute in 1872, with excellent results, should be applied to the Navy.

BUREAU OF NAVIGATION.

The chief of the Bureau of Navigation, Commodore John G. Walker, reports the operations of the Bureau in reference to the manufacture and testing of compasses, the examination of compass reports from cruising vessels with a view to the preparation of a new variation chart, and the publication and distribution of information on the magnetism of iron and steel ships. The erection of the new compass-testing house has been begun, and a compass station for the accurate determination of deviation has been established in Narragansett Bay. The report dwells upon the urgent necessity of establishing compass stations at the principal seaports, for the benefit of the merchant marine, under the direction of naval officers.

In connection with the subject of ocean surveys, it is recommended that the Thetis be employed in examining the imperfectly-surveyed coasts in the Pacific frequented by merchant vessels.

The chief of Bureau also reports on the condition of the Nautical Almanac Office, the Department library, and the War Record Office; on the progress of work on the revision of the naval signal books; on the publication of the results of observations for the telegraphic determination of longitudes, and on the supply of the various materials and instruments under the charge of the Bureau, including illuminating oils, electric lights, chronometers, and books for the libraries of ships of war.

The steady decrease in the appropriation for the purchase of necessary supplies, together with the gradual exhaustion of the surplus materials on hand at the close of the war, leaves the Bureau in a crippled

condition, and an increase of the appropriation to the amount called for by the estimates is urgently needed.

The preparation of the Naval Records of the War for publication has been partly completed, but an additional force, for which estimates have been submitted, is needed to carry on the work. It is desirable that no time should be lost in securing the valuable papers, now in private hands, relating to naval affairs during the war, and that provision should be made for an agent for the collection of Confederate documents.

BUREAU OF ORDNANCE.

The report of the Chief of the Bureau of Ordnance, Commodore Montgomery Sicard, describes the operations of the Bureau in reference to the design, construction, and testing of guns and torpedoes, and to experiments and improvements in gunpowder, gun-cotton, gas-checks, gun-carriages, torpedoes and their fittings, ammunition for the Hotchkiss gun, and electrical apparatus for firing great guns.

Work of all kinds has been pushed forward rapidly at the ordnance department of the Washington navy-yard. It will require a considerable quantity of modern machinery to place this department on a suitable footing. The instruction of the seamen gunners continues at the yard as well as at the torpedo station, and a class of "continuous service" men is also receiving instruction at both places.

Satisfactory progress has been made in the ordnance of the new cruisers, five 6-inch and two 5-inch breech-loading high-power steel guns having been completed since the last report, at the Washington yard. They have been satisfactorily tested at the Naval Ordnance Proving Ground, and several will be mounted on the Atlanta when she is ready to receive them. Of the twenty sets of steel forgings for 6-inch guns ordered from the Midvale Steel Company nineteen have passed inspection and been delivered.

The work of machine-finishing and assembling forgings has made satisfactory progress at the South Boston Iron Works and the works of the West Point Foundry Association, and several 6-inch guns will shortly be finished. The forgings for 8-inch guns have just arrived from England, being more than a year overdue, a delay which shows the importance of having a heavy gun-forging plant in the United States.

Designs have been made for the batteries of the four ships projected in the act passed at the last session of Congress, and estimates have been prepared for a modern armament for six of the present third-rate ships of the Navy.

Estimates have also been submitted for the armament of the double-turreted monitors.

The naval ordnance proving ground has remained under the charge of Commander William M. Folger, and much important and active work has been done there during the year, including the testing of guns; ascertaining the best composition and temper of steel for armor-piercing

projectiles, and the resistance of steel and other armor plates; the measurement of chamber pressures in the different classes of guns; the employment of gun-cotton in armor-piercing projectiles, and vari other very important operations. Successful experiments have been made with the new high-power musket with satisfactory results, the bullet perforating one inch of steel at short range with reserve of force sufficient to kill two men. The experiments with Clark's deflective turret have been delayed by the want of funds and steel with which to complete the 10-inch gun to be used in the trial; but the material and money are now available, and the gun will be pushed to completion soon as the tests of the steel are made.

The present site of the proving ground at Annapolis is very defective for a number of reasons, to which attention is called in the report of the Chief of Bureau, and it is highly desirable to obtain a new site as early as possible.

The trials of the Howell torpedo show that it possesses certain valuable qualities and a further examination is being made of the system.

The torpedo station, under the charge of Commander William T. Sampson, has continued its work in the manufacture of gun-cotton and in the elaboration of designs and the improvements of various details in reference to the action of torpedoes. The usual course of instruction, embodying some improvements, was given during the summer with excellent results, and an advanced course of instruction for a limited number of officers has been arranged to follow the general course, and has gone into operation.

BUREAU OF CONSTRUCTION AND REPAIR.

The report of Chief Constructor Theodore D. Wilson describes the work done by his Bureau, recommends the purchase of supplies by annual schedule, presents with some detail his views as to the requirements of the Navy in the matter of new steel vessels, and urges the completion of the monitors. The report expresses the opinion that it should be the policy of the Government to maintain one large navy-yard, combining in itself the advantages and facilities of all the others, and advocates League Island as the most advantageous site for this purpose. In the event of an appropriation being made for more steel ships, the Bureau hopes that at least one-half of the ships may be built in our navy-yards, in competition with outside establishments, and it dwells with emphasis upon the serious obstacle existing at the present time in the want of docking facilities. The report closes with the presentation of certain considerations in reference to the education of naval constructors.

BUREAU OF STEAM-ENGINEERING.

The report of the Chief of the Bureau of Steam-Engineering, Engineer-in-Chief Charles H. Loring, contains an account of expenditures

during the past year, and describes the present condition of the machinery of naval vessels, and the work required to be done to fit them for sea service or to keep them on such duty during the next fiscal year. The report dwells upon the necessity of building a new boiler-shop at the New York navy-yard.

BUREAU OF MEDICINE AND SURGERY.

Surgeon-General Francis M. Gunnell reports on the condition and operations of his Bureau during the past year. The report states that the Bureau has not been able to maintain the hospitals in a satisfactory condition for want of sufficient appropriation. A temporary hospital or quarantine station to which naval vessels containing yellow-fever patients might be sent has been established on Widow's Island, off the coast of Maine. Instructions have been issued to the surgeon in charge of the United States naval hospital at Yokohama to receive and care for sick seamen from American merchant vessels in the same manner as for enlisted men in the Navy.

The trials in the courts of the District of Columbia for frauds perpetrated on the Government through this Bureau have resulted in the conviction of the two indicted clerks and of several accomplices. Others are to be tried at the next term of the court.

The Museum of Hygiene continues to make satisfactory progress. During the past year it has made valuable additions to its collection and has conducted important experiments.

MARINE CORPS.

The report of Col. Charles G. McCawley, commandant of the Marine Corps, shows a satisfactory state of discipline and efficiency in the corps during the year, and especially in the difficult and arduous service in April on the Isthmus of Panama, and recommends an increase of 500 privates in the number of the force. It also calls attention to the fact that the Marine Corps should have a complete outfit of tents and camp equipage for 500 men. These supplies cannot be purchased with the present appropriation.

HYDROGRAPHIC OFFICE.

The Hydrographic Office has made numerous improvements during the past year in the construction, arrangement, and mode of issue of charts and sailing directions, which are described in detail in the report of the hydrographer, Commander John R. Bartlett. The collection of nautical information from a great variety of sources, and its dissemination for the benefit of the merchant marine and in the interests of safe navigation, especially through the monthly pilot chart and the notices to mariners, have been carried on with increased thoroughness, promptness, and efficiency. Invaluable assistance has been rendered in this direction by the branch hydrographic offices established in the principal

seaports, the work at these offices having been more than doubled during the past year.

The publication of charts from the important surveys of the west coast of Mexico and Central America, performed by the officers of the Ranger, awaits a special appropriation.

In view of the impossibility of carrying on the work of chart printing in the executive building, and the necessity that the valuable engraved plates of charts, representing the labor and expenditure of many years, should be removed from all danger of destruction by fire, it is recommended that a fire-proof building for storing the plates and printing charts should be erected.

NAVAL ACADEMY.

The Superintendent of the Naval Academy, Capt. Francis M. Ramsay, reports that the prescribed course of instruction has been carried out during the past year and the usual practice cruise has been made. The most important improvements in buildings and grounds have been the enlargement of the cadets' sick quarters and the partial renewal of the system of drainage of the Academy.

The Superintendent recommends that permits should be issued to candidates a year in advance of their admission, and that they should report for examination by the 15th of May. It is also recommended that changes be made in legislation, by which the selection of cadets to fill vacancies in the lower grades of different corps may take place at the completion of the four years' course instead of after the six years' course, as at present, and that certain legislative provisions prescribed for the Military Academy be applied to the Naval Academy.

NAVAL OBSERVATORY.

The report of the Superintendent of the Naval Observatory, Commodore George E. Belknap, presents a statement of the astronomical work performed during the year with the various instruments, of the observations of the eclipse of March 15, and of the transmission of correct time to the principal cities and seaports. A report is also made of the work done for the Transit of Venus Commission, relating to the observations made in 1874 and 1882.

The time service is now performed, with the gratuitous co-operation of the telegraph companies, at Boston, Newport, the New York navy-yard, Philadelphia, Hampton Roads, Savannah, New Orleans, and San Francisco. Requests received from other cities for an extension of the system can only be complied with upon an increase of the appropriation for the purpose.

It is strongly urged that appropriation should be made for the erection of the new observatory upon the site already purchased by the Government for that purpose. The plans for the structure are now prepared, and no time should be lost in effecting a removal from the dilapidated buildings and unhealthy site of the present Observatory.

NAVAL WAR COLLEGE.

The Naval War College began its first session September 3, under the direction of Rear-Admiral Stephen B. Luce, president of the college. The instruction consisted of lectures on military science, the art of naval warfare, and marine international law. The college, now fairly in operation, by giving officers an advanced course of instruction on subjects directly connected with the most important duties of the profession, fills what has hitherto been a serious want in our system of naval education.

SALE OF OLD VESSELS AND GOVERNMENT PROPERTY.

The only condemned vessels sold during the past year were the hulk Niagara, at Boston, and the tug Rose, at Pensacola, Fla.; the amount realized for the former, after paying auctioneer's commission, being $12,117, and from the latter $419.25. An account of the receipts and expenditures in connection with the sale of old vessels will be found in the appendix to the report.

The deposits from the sale of Government property under the control of the Navy Department, including sums realized from difference in exchange, interest paid by the foreign fiscal agents, and those from other sources, classed as "miscellaneous receipts," under section 3618 of the Revised Statutes, from November 1, 1884, to November 1, 1885, amounted to $233,040.31, as shown by the statement of the Fourth Auditor of the Treasury, which will also be found in the appendix to the report. Of this sum, $197,324.51 were covered into the Treasury as "miscellaneous receipts on account of proceeds of Government property," and $35,715.80 were deposited to the credit of sundry appropriations, as directed by the statutes governing such cases.

DECORATION DAY.

A joint resolution of Congress, approved January 6, 1885, provides that all per diem employés of the Government on duty at Washington and elsewhere in the United States shall be allowed certain holidays, and shall receive the same pay as on other days. The days named in the resolution are the 1st day of January, the 22d day of February, the 4th day of July, the 25th day of December, and such days as may be designated by the President as days for national thanksgiving.

It is recommended that the resolution be amended so as to include the day which is generally observed throughout the United States as Decoration Day.

Under section 1545 of the Revised Statutes, per diem employés in the navy-yards can receive pay for the time only during which they may be actually employed, and as all such should have an opportunity of par-

ticipating in the commemoration of those who fell during the late w without being deprived of a portion of their livelihood, an amendm of the law as indicated would seem to be manifestly appropriate.

EXPENDITURES.

The amount of appropriations applicable to the current expenses of the first six months of the fiscal year was $7,255,283.48, the amount for the last six months of said year ending June 30, 1885, $6,230,253.85, making the total amount $13,485,537.33, in which is included $47,362 transferred from navy-yard Brooklyn, N. Y., 1884, to that appropriation 1885 per appropriation warrant No. 383, $140,000 from machinery double-turreted monitors, indefinite, to steam engineering, 1885, per appropriation warrant No. 390, and $2,191.87 pay miscellaneous 1885, appropriated to supply deficiencies for said fiscal year per appropriation warrant No. 391.

There was a balance on hand at the commencement of the fiscal year on account of pay of the Navy and pay of the Marine Corps of $2,407,491.35. The total gross amount, therefore, which was available for the year was $15,893,028.68. There should, however, be deducted from this amount the sum of $59,813, appropriated for the Naval Asylum, as that sum was brought to the credit of the asylum February 25, 1885, by requisition in its favor, and is included in the exhibit of expenditures chargeable to Navy appropriations at that time as refunded and deducted from the amount drawn in that month, also $1,407,272.87 due to general account of advances, which leaves a balance of $14,425,942.81 available for the year, being $1,504,828.93 less than the amount available for the fiscal year ending June 30, 1884.

The net amount drawn from the Treasury by warrant during the last fiscal year was $13,337,867.72, as shown by the books of the Department, which leaves a balance undrawn of $1,088,075.09; to this should be added the net amount unexpended in the hands of pay officers on said June 30, 1885, as shown by the office of the Fourth Auditor, $1,265,570.64, leaves an aggregate balance unexpended of $2,353,645.73, which stood to the credit of the Department at the beginning of the present fiscal year. That is, the total net expenditure for the fiscal year ending June 30, 1885, was that much less than the appropriations. The annexed table shows the amount of expenditures by warrant and the amount refunded, as well also as that expended from the close of the year to November 1, 1885.

The appropriations available for the present fiscal year, commencing July 1, 1885, are $13,590,704.95. The amount drawn by warrant from the Treasury from July 1, 1885, to November 1, 1885, deducting that refunded, is $4,285,761.39. The amount drawn by warrant during the same period of last year was $4,383,244.93.

The amount of appropriations applicable to the current expenses

of the fiscal year ending June 30, 1885, was $13,485,537.33, as shown by the following table:

Statement of appropriations and expenditures for the fiscal year ending June 30, 1885.

Appropriations.	Balances on hand June 30, 1884.	Appropriations for fiscal year ending June 30, 1885.	Amounts applicable to the service for the fiscal year ending June 30, 1885.	Amounts expended fiscal year ending June 30, 1885.	Balances June 30, 1885.
Pay of the Navy	$2,182,550 75	$6,917,605 00	$9,100,155 75	$6,832,983 50	$2,267,172 25
Pay, miscellaneous		339,691 87	339,691 87	335,993 42	3,698 45
Contingent, Navy		57,500 00	57,500 00	54,165 74	3,334 26
Pay of the Marine Corps	224,940 60	653,240 36	878,180 96	603,094 89	275,086 07
Quartermaster's department of the Marine Corps		217,436 50	217,436 50	206,455 20	10,981 30
Naval Academy		181,256 10	181,256 10	177,049 40	4,206 70
Navigation and navigation supplies		87,500 00	87,500 00	70,543 72	16,956 28
Ordnance and ordnance stores		125,000 00	125,000 00	117,736 88	7,263 12
Repairs, ordnance		15,000 00	15,000 00	9,514 52	5,485 48
Steel rifled breech-loading guns		41,632 50	41,632 50	40,902 99	729 51
Torpedo corps		50,000 00	50,000 00	43,837 13	6,162 87
Equipment of vessels		750,000 00	750,000 00	682,122 21	67,877 79
Transportation and recruiting		25,000 00	25,000 00	24,921 44	78 56
Naval training station		21,000 00	21,000 00	18,048 07	2,951 93
Maintenance (Yards and Docks)		200,000 00	200,000 00	192,980 70	7,019 30
Navy-yard, Brooklyn, N. Y.		77,362 00	77,362 00	32,133 03	45,228 97
Navy-yard, Mare Island, Cal.		250,000 00	250,000 00	186,141 18	63,858 82
Repairs and preservation at navy-yards		125,000 00	125,000 00	121,646 34	3,353 66
Naval Asylum, Philadelphia, Pa.		59,813 00	59,813 00	46,054 45	13,758 55
Surgeons' necessaries and appliances		40,000 00	40,000 00	19,349 58	20,650 42
Naval Hospital fund		30,000 00	30,000 00	29,974 21	25 79
Repairs (Medicine and Surgery)		10,000 00	10,000 00	8,726 98	1,273 02
Provisions, Navy		1,100,000 00	1,100,000 00	983,979 72	116,020 28
Construction and repair		1,000,000 00	1,000,000 00	972,847 86	27,152 14
Steam machinery		920,000 00	920,000 00	801,782 42	118,217 58
Contingent (Bureaus)		92,500 00	92,500 00	73,784 02	18,715 98
Civil establishment at yards and stations		99,000 00	99,000 00	95,191 34	3,808 66
Add this amount, difference in general account of advances (which is not an expenditure), being June 30, 1884, $1,407,272.87, and June 30, 1885, $2,022,992.65 difference				615,719 78	
	2,407,491 35	13,485,537 33	15,893,028 68	13,397,680 72	3,111,067 74
Deduct on account of Naval Asylum as heretofore explained				59,813 00	
Also amounts due general account and Naval Asylum, June 30, 1884			1,467,085 87		
And amount due general account of advances, June 30, 1885					2,022,992 65
Net amounts			14,425,942 81	13,337,867 72	1,088,075 09

The above balance of $3,111,067.74 does not include the amount unexpended in the hands of pay officers at that time, which, as furnished by the office of the Fourth Auditor, is $1,265,570.64.

Net amounts drawn during the fiscal year ending June 30, 1885.

Appropriations, 1885	$13,337,867 72
Appropriations, 1884	383,079 26
Appropriations, 1883	72,023 61
Appropriations, indefinite	2,221,501 51
	16,014,472 10
Less amount refunded appropriation 1883-'84	78
Total drawn fiscal year ending June 30, 1885	16,014,471 32

Statement of appropriations for the fiscal year ending June 30, 1886.

Pay of the Navy	$6, 940 [illegible]
Pay, miscellaneous	375 [illegible]
Contingent, Navy	20, [illegible]
Pay of the Marine Corps	649, [illegible]
Quartermaster's department, Marine Corps	219, [illegible]
Naval Academy	181, [illegible]
Navigation and navigation supplies	87, [illegible]
Ocean surveys	10, [illegible]
Naval War College	8, [illegible]
Ordnance and ordnance stores	146, [illegible]
Repairs (Ordnance)	15, [illegible]
Torpedo corps	60, [illegible]
Equipment of vessels	800, [illegible]
Transportation and recruiting (Equipment and Recruiting)	30, [illegible]
Naval training station, Coasters' Harbor Island, R. I	25, [illegible]
Maintenance (Yards and Docks)	200, [illegible]
Navy-yard, Brooklyn, N. Y	30, [illegible]
Navy-yard, Mare Island, Cal	276, [illegible]
Repairs and preservation at navy-yards	125, 000
Naval Asylum, Philadelphia, Pa	59, 867
Medical Department (Medicine and Surgery)	60, 000
Naval Hospital fund	30, 000
Repairs (Medicine and Surgery)	10, 000
Provisions, Navy	1, 085, 000
Construction and Repair	1, 000, 000
Steam-Engineering	950, 000
Contingent, Bureaus	118, [illegible]
Civil establishment at yards and stations	79, [illegible]
	13, 590, 704

ESTIMATES.

The estimates for the Navy for the fiscal year ending June 30, 1887, amount to $35,104,695.15, as shown by the following summary:

Summary of the estimates for the Navy for the fiscal year ending June 30, 1887.

General maintenance yards and stations (Yard and Docks)		$300, 000 00
Support of the Naval Asylum (Yards and Docks)		96, 661 00
Equipment of vessels, coal, hemp, &c. (Equipment and Recruiting)		860, 000 00
Transportation and recruiting (Equipment and Recruiting)		30, 000 00
Equipment plant, Washington yard (Equipment and Recruiting)		38, 894 00
Preservation and repair of vessels (Construction and Repair)		2, 000, 000 00
Steam machinery, boilers, &c. (Steam-Engineering)		840, 000 00
Provisions (Provisions and Clothing)		1, 221, 825 00
Navigation supplies (Navigation)	$130, 000 00	
Ocean surveys and publications thereof (Navigation)	37, 000 00	
Repairs, improvements, and Naval War College (Navigation)	14, 000 00	
Observation of transit of Venus (Navigation)	3, 000 00	
Completing compass-testing house (Navigation)	2, 000 00	
Publication of professional papers (Navigation)	12, 000 00	
		198, 000 00
Procuring and preserving ordnance material, &c. (Ordnance)	177, 500 00	
Batteries of the new types for six ships (Ordnance)	670, 000 00	
Thirty machine cannon, modern caliber (Ordnance)	93, 000 00	
Twenty musket caliber machine-guns (Ordnance)	55, 000 00	
Magazine and cadet rifles, equipments, &c. (Ordnance)	44, 250 00	
Proof of naval guns and appendages (Ordnance)	6, 000 00	
Modern armament for two t aining vessels (Ordnance)	10, 000 00	
Land and buildings for proving ground (Ordnance)	57, 000 00	
Repairs to ordnance building (Ordnance)	15, 000 00	
		1, 127, 750 00
Torpedo corps and station, labor, material, freight, &c. (Ordnance)	75, 500 00	
Purchase of auto-mobile torpedoes, fast torpedo-boat, &c	175, 000 00	
		250, 500 00
Steel rifled breech-loading gun (Ordnance)		60, 000 00
Machinery for ordnance (Ordnance)		50, 000 00
Surgeons' necessaries and appliances (Medicine and Surgery)	60, 000 00	
Naval Hospital fund (Medicine and Surgery)	30, 000 00	
Repairs to hospitals (Medicine)	40, 000 00	
		130, 000 00
For increase of the Navy:		
Bureau of Construction and Repair	5, 150, 000 00	
Bureau of Steam Engineering	3, 750, 000 00	
Bureau of Ordnance	878, 770 00	
Bureau of Equipment and Recruiting	725, 000 00	

Double-turreted monitors:		
Bureau of Construction and Repair	2,923,656 00	
Bureau of Steam-Engineering	206,000 00	
Bureau of Ordnance	1,073,000 00	
		4,202,656 00
Civil establishment at yards and stations		248,458 12
Contingent expenses under Bureaus and contingent, Navy		165,500 00
Support of the Naval Academy		190,884 45
Support of the Marine Corps		918,841 67
Public work and improvements:		
Quarters for cadets at the Academy	120,000 00	
New Naval Observatory	250,000 00	
Improvements Coasters' Harbor Island	30,000 00	
Improvement and preservation yards and stations	3,868,337 41	
		4,268,337 41
Pay of the Navy (officers and enlisted men)		7,129,087 50
Pay, miscellaneous		273,530 00
Total		35,104,695 15

DISTURBANCES AT PANAMA.

On the 16th day of March last an insurgent demonstration against the Colombian Government, under the lead of Aizpuru, resulted in the occupation of the town of Panama by the insurgents and in such obstruction to the operations of the Panama Railroad as virtually to close the transit. Upon the arrival of a detachment of national troops from Aspinwall, however, Aizpuru was forced to retire.

During the absence of the national forces from Aspinwall, another insurrectionary movement was successfully made at that place under the leadership of Prestan. On the 1st of April an encounter took place between Prestan and the forces of the Government outside of Aspinwall, in which Prestan was defeated. During the conflict the city of Aspinwall was set on fire by the insurgents and in great part destroyed. Meantime Aizpuru succeeded in reoccupying Panama and the greater portion of the Isthmus included along the line of the railroad, thereby effectually blocking the transit of trains.

Under these circumstances it became evident that the occasion had arisen for the enforcement of the rights secured to the United States by the following clause of our treaty of 1846 with New Granada (United States of Colombia):

"And, in order to secure to themselves the tranquil and constant enjoyment of these advantages, and as an especial compensation for the said advantages, and for the favors they had acquired by the fourth, fifth, and sixth articles of this treaty, the United States guarantee, positively and efficaciously, to New Granada, by the present stipulation, the perfect neutrality of the before-mentioned Isthmus, with the view that the free transit from the one to the other sea may not be interrupted or embarrassed in any future time while this treaty exists; and in consequence, the United States also guarantee, in the same manner, the rights of sovereignty and property which New Granada has and possesses over the said territory."

In order the more effectually to maintain the rights of the United States as defined by the treaty, the vessels of the North Atlantic squadron under Rear-Admiral Jouett, with the exception of the Yantic, were ordered to Aspinwall, where they arrived on April 10. Previously to their arrival, the U. S. S. "Galena," which had been lying off the port, had sent ashore a landing party of seamen for the purpose of protecting American property at that point, while a landing party from the U. S. S. "Shenandoah" was performing a like service at Panama.

In addition to the ships already sent to Aspinwall, the Depart promptly dispatched an expeditionary force from New York for special purpose of operating on shore. This force, consisting of ab 750 seamen and marines, under the command of Commander B. H McCalla, and including three Gatling guns and three 3-inch ri guns, sailed from New York; the first detachment, comprising first battalion of marines, in the steamship City of Para, on April 3 and the second, comprising the remainder of the force, in the steamship Acapulco, on April 7. The steamships arrived at Aspinwall on 11th and 15th of April, respectively.

Immediately upon his arrival at Aspinwall, on the 10th of April, Rear-Admiral Jouett issued orders for the landing of a force to open the transit across the Isthmus. In accordance with these orders, garrisons were placed at Aspinwall and at Matachin, and the first detachment of the expeditionary force from New York, immediately upon its arrival out, was ordered to Panama.

Two armored cars also were fitted up and equipped with howitzers, Gatlings, and Hotchkiss guns for patrol duty along the line of the railroad. All these arrangements were completed on the 11th of April, and on the 12th regular schedule trains were run over the road, and have continued to run without further interruption.

Upon the arrival of the Acapulco, on the 15th of April, the expeditionary force relieved the detachment which had been landed from the squadron, and Commander McCalla, in accordance with the instructions of the Department and the orders of Rear Admiral Jouett, assumed command of all the United States forces on shore. On the 21st of April the headquarters of the expeditionary force, together with two companies of marines, were transferred from Aspinwall to Panama, at that time occupied by Aizpuru, who was erecting barricades to resist the expected attack of the national troops, then on their way to the city. As many of the persons composing Aizpuru's force had taken part in the burning of Aspinwall, it was feared that a conflict at Panama might there result in a similar disaster. Commander McCalla therefore, on the 24th, ordered up the garrison from Aspinwall, together with the reserve battalion of marines from the squadron, occupied the city; arrested Aizpuru and other revolutionary leaders, and detained them until a stipulation was signed that fighting should not take place nor barricades be erected within the limits of the town.

On the evening of the day on which this agreement was executed (the 25th) our naval force was withdrawn to a position at the railroad depot outside of the city, from which all the avenues of approach to Panama could readily be occupied. On the 27th a landing party from the Iroquois, which had arrived off Panama the day previous, came ashore and was quartered for the night at the railroad wharf.

On the 28th the national forces, under Colonels Montoya and Reyes, arrived from Buenaventura, and the day after a conference took place

between these officers, Aizpuru, and Rear-Admiral Jouett, which resulted in the capitulation of the insurgent troops.

The re-establishment of the national authority having rendered the presence of our expeditionary force no longer necessary, the greater part of it returned to New York, where it arrived on the 16th of May, and by the 25th of May all the United States forces had withdrawn from the Isthmus.

The officers and men charged with restoration of the freedom of transit on the Isthmus, in accordance with the provisions of the treaty of 1846, discharged their duty in a highly satisfactory manner. The action of the Department was carefully confined to measures only as were necessary to enforce treaty stipulations, every precaution being taken to respect the autonomy of Colombia; and our interference ceased the moment the object had been accomplished and the freedom of transit had been securely re-established. Among the results of these naval operations upon the Isthmus, by no means the least gratifying, has been the establishment of still closer and more friendly relations with a sister republic, while our commercial and other interests in Central America have been strengthened, and an additional guarantee of security has been given to the mercantile enterprise of Americans in this quarter. It is largely for the purpose of protecting the mercantile marine and for assisting its healthy development that the Navy exists; and there are reasons for believing that its services on the Isthmus during the months of April and May last will have important and far-reaching consequences in this direction.

THE ADDITIONAL NEW CRUISERS.

At its last session Congress authorized the construction of two additional cruisers and two gunboats, at an aggregate cost of not exceeding $2,995,000. No appropriation for the armament of these ships was made, the preparation of which requires at present a longer period than would be probably employed in the construction of the ships.

Early in May last (anticipating the date when the appropriation would become available, viz, July 1) it was decided to proceed, in accordance with the law, with the work incident to the construction of the ships. The terms of the act provided:

> And authority is hereby given for the construction of said four vessels at not exceeding the total cost for each above specified, in accordance with such final plan as may be determined upon after a revision and reconsideration of all designs which have been heretofore made, and in the manner and in conformity to the conditions and limitations provided for the construction of the new cruisers in the acts of August 5, 1882, and of March 3, 1883, except so far as said acts provide for and define the duties of the Naval Advisory Board.

One of the provisions of the act of 1882 directed the Secretary of the Navy to invite, by public advertisement, the submission of plans by engineers and mechanics of established reputation, naval constructors, and others, within a period, not less than sixty days, to be named. Some

doubt was entertained by the Department as to whether this obligation attached to the construction of these new vessels, but it was deen wise to solve it in favor of the public advertisement, and accordii such advertisement was made, the time for the submission of pi thereunder expiring upon the 15th day of July last.

A large number of models and plans were received at the De ment, and as the law contemplated the thorough examination of su matter, the same were, upon the 29th day of July, referred to a Board for examination and report thereon.

In addition thereto the Board were required to report to the Department their recommendations as to the characteristics to be attained in the proposed new ships, with preliminary plans, for the consideration of the Department. Upon the 18th day of September last, after painstaking and elaborate investigation, the Board submitted their report, embodying their views of the characteristics which the Department ought to secure in the construction of the ships.

The same was thereupon, with the preliminary plans, referred to the Bureaus of Construction and Engineering, with directions to proceed with the preparation of detailed plans and specifications. That work is still in progress.

It is the desire of the Department to avoid the long delays which have occurred in the construction of the ships now in process, arising from the making of changes in the plans after the letting of the work. It is believed that careful preparation of details at the outset will avoid this harassing difficulty.

Meanwhile a great effort has been made to gather, for the information and use of the Department, plans of the latest work of eminent naval constructors of other countries.

In this work the Department has recived important aid from Commander Chadwick, the naval attaché at London, as well as from Lieutenant Jaques, while acting under the detail of the Department as the secretary of the Senate Committee on Ordnance.

Within the next thirty days it is believed that the plans will be sufficiently advanced as to justify the commencement of the advertisements, and it is perhaps well that attention should be called to the fact that the ships are likely to be finished at a period long prior to the probable completion of their armament.

There is a growing interest in the matter of this Government work, and the field of the bidders will, I think, be larger than ever before. Several large builders of engines and machinery have expressed a desire to be permitted to compete for the construction of the machinery of the new ships, and it may be decided to separate the hull and her fittings from the machinery in the advertisement, as is sometime done in other countries. In that event the field of the bidders would probably be greatly increased.

THE DOLPHIN, BOSTON, ATLANTA, AND CHICAGO.

Upon my accession to office the Department had in process of construction, under contract with Mr. John Roach, three modern steel cruisers and one dispatch boat. They constituted the first attempt of the Navy Department for many years to construct a war vessel up to the modern requirements. They should be looked upon and judged as such. As such they will, I trust, be found in the main creditable to those who have been engaged in their creation. They will certainly, if they have been well built, be an improvement upon the previous work of the Department, but it is not profitable to consider them as standards of excellence for future work, nor was it to be expected that they would be.

It is to be regretted (I think all will now accede to this suggestion) that greater deliberation was not had over the preparation of the plans. It seems that the plans had not been prepared when the publication of the advertisement for proposals for bids was first made. In fact, they were not passed upon and approved by the Advisory Board and finally settled until about the day when the bids were to be submitted. From the complaints of the contractor (largely, I am inclined to think, just) long delays took place in settling details after the contracts were entered into.

In the case of the Chicago more than six months of delay in the work was admitted by the Advisory Board as attributable to these causes, and to the delays arising from changes in plans, and a much longer time is claimed by the contractor. Greater deliberation over the plans would likewise, doubtless, have resulted in the avoidance of some serious mistakes.

The Dolphin, as she now is, should be regarded as a pleasure boat rather than as a dispatch boat. The absence of the most ordinary and approved devices for protection against hostile fire in her design take her out of the category of war vessels. The use for instance of vertical engines, exposing her machinery above the water-line in a vessel without armor protection, is far from being good practice at this time. In fact, she does not bear favorable comparison with similar vessels built at about the same time by other countries.

The Surprise, built by the English Government contemporaneously with the construction by us of the Dolphin, has horizontal engines placed below the water-line, with a horizontal steel protective deck and with coal protection in addition. She has 40 water-tight compartments as against the Dolphin's 6. Her machinery weighed 10 per cent. less than the Dolphin's and produced 20 per cent. more power, and her speed is from two to three knots better than that of the Dolphin. The vital parts of the Dolphin are so exposed that under fire she would be quite useless; yet her design is chargeable to the Government. At the present time it is quite profitless to discuss her characteristics. She

doubtless would not be thought worthy of duplication at the present time by any one.

Upon the 18th of March last a paper was presented to me for examination and signature, constituting an acceptance of the Dolphin on behalf of the Government. Having been then less than two weeks in office, I took the papers for examination. From these papers it appeared that she had not upon her trial fulfilled one of the conditions requisite under the contract for her acceptance; namely, she had not developed and maintained twenty-three hundred indicated horse-power during the trial required by the contract. In that event the contract placed upon me a serious responsibility. It said:

Provided, That in case of the failure of the development of this power, the vessel shall be accepted if it can be shown to the satisfaction of the Naval Advisory Board and the Secretary of the Navy that this failure was due neither to defective workmanship nor material.

The Advisory Board, in referring to this failure on her part, said:

The Board is of opinion that the deficiency of 188 power from mean of 2,300, required by the contract, for six consecutive hours, was not due to defective workmanship nor material, *but that with better coal and a well-trained engineer force this result will be exceeded.*

From this it appeared that they passed her somewhat conditionally; at all events, upon a supposition the correctness of which it was quite easy to test.

Upon the 20th of March, therefore, a communication was sent by the Department to the contractor suggesting another trial, with a view of reaching an easy and quick settlement of the matter. An immediate reply was expected, and it was supposed that the trial might be had and the whole matter disposed of within a few days. More than two weeks having passed without any reply to this suggestion, I decided to have an examination made of the vessel. For that purpose there was selected Commodore Belknap, unknown to me, whose reputation is second to none of his rank in the service; Commander Evans, who for some time had been engaged in the inspection of steel at the city of Pittsburgh, and who possessed a high reputation for knowledge and experience in that regard; and Mr. Herman Winter, a marine engineer known to me to be of the highest standing, character, and reputation. No other expectation was entertained but that their examination would justify an immediate acceptance of the vessel; and upon April 7 the president of the Advisory Board was notified of my action by the following letter:

SIR: After examining the contract and laws relating to the construction of the Dolphin, I am of opinion that the act performed by me in passing upon the final payment and plans is not a formal act, but one with reference to which I seem to have responsibility.

I have neither the time nor the expert knowledge with which to possess myself of the necessary information upon which to base a judgment, and while if I had been present in the Department during the construction of the vessel I should doubtless

be possessed of a matured opinion and judgment upon the subject, under the present circumstances that is quite impossible.

In view of the fact that my formal act is required in addition to the act of the Advisory Board, it is quite evident it was not intended that I should rely solely upon the action of the Advisory Board in this matter; otherwise, the action of the Secretary would not be required. I have, consequently, decided to designate three persons, who have not been connected with the construction, for the purpose of assisting me in the discharge of the duty which, without such aid, it is quite impossible for me to perform.

I desire to notify your Board of my action, that it may not be construed to arise from any intention to reflect upon the correctness of the conclusion to which the Advisory Board has come.

On the 7th of April, contemporaneously with the appointment of the Examining Board, I addressed the contractor calling his attention to the fact that he had made no reply to that portion of my letter of March 20, suggesting another trial for the Dolphin. It is proper for me to say in justice to the contractor that he afterwards stated to me that my first letter of March 20, containing a suggestion of another trial, he considered to be merely suggestive and not requiring an answer, and that he had no recollection of having received the second letter of April 7 calling his attention to the fact that he had not answered my former letter.

Upon the 5th of May, after about six weeks silence, he assented that a trial should be had; and in accordance with his request Long Island Sound was assigned as the place of trial, and his request that the Advisory Board should be present was also acquiesced in. Two unsuccessful attempts at a trial subsequently ensued, after each of which the contractor desired a further opportunity, to which I acceded. At one of these interviews, referred to by me in a letter of May 22 to the contractor, he stated that the boat had not the speed nor the horsepower contemplated by the contract, but denied responsibility therefor.

The third attempt resulted in a six hours' run, but she did not reach the limit of power required by the contract, and upon the 15th of July the Examining Board reported the results of her examination. This report was replied to by the Advisory Board upon the 13th of July, which in turn was reviewed by the Board of Examination on the 31st of July. From a comparison of the statements of these reports certain things must be conceded as having been established. Of course a completed ship can only be judged as to her character by what can be seen. It is too late to pass any very satisfactory judgment upon her merits, and this fact has been commented upon in the report of the Examining Board. Only surface indications are available as indicating the character of her work. From these reports it appears that the contractor, immediately upon the selection of the Board, proceeded to remedy defects which were apparent in her construction.

The first report says:

Since the Board began its detailed examination, the results of which are embodied in this report and its addenda, the contractor has been at work upon the vessel from time to time in remedyin defects discovered by the Board, and the Dolphin is now in

much better condition and appearance than when the Board first saw her, and in some important regards she is substantially improved.

For instance, she has been stiffened forward in the forepeak abreast the haw by a vertical plate-brace, a point where special weakness was observed; in the transom, where the reverse-frames were cut off, the cut frames have been connected by a floor-plate; the spar-deck and berth-deck have been calked fore and aft; the step of the mizzenmast, which was weak and insecure by reason of defective support, has been strengthened to a degree promising perfect security; the skin of the vessel has been repainted at various points where the skin was accessible; the hold storerooms, fore and aft, have been freshly painted and fitted with proper shelving, and other things have been done in the direction of making the Dolphin a much better ship than the Board found her on its first inspection.

In their supplemental report, reviewing the answer of the Advisory Board, they explain that "the Board had no authority to ask or authorize any changes that were made," and they state that no mention was made of their discoveries to the contractor, but that what he did was upon his own opinion as to the necessities of the case, or that of his advisers. Thus the action of the Department in causing an investigation to be made had been fully justified by the admissions made by all the parties of defects then existing in the ship. This left the question of whether the loose inspection which these defects indicated had existed throughout the construction; and with regard to this it was, of course, quite difficult to satisfactorily ascertain, except inferentially.

The decision of the Department was that under the circumstances no point could properly be made with regard to her general workmanship, the contractor having remedied and being willing further to remedy apparent defects, and there were left but two points in the case for consideration; the one was her speed, and the other her strength. The results of the trials had shown that she had not the speed contemplated by Congress in making the appropriation, nor that which similar boats built contemporaneously elsewhere were given, and a question was raised, although no positive statement was made, with regard to her strength. The Board state in full the circumstances considered by them with reference to her strength, and state that "nothing short of a trial at sea for some time and in rough water can satisfactorily determine her actual strength and weakness," and expressed regret that it was a mere matter of opinion without such a test.

Under the circumstances the Department decided to submit the question to the Attorney-General, whether, under the contract and law, the contractor was responsible for the speed and strength of the vessel. The opinion is annexed with other papers, the decision being that he was responsible both for the speed and the strength of the ship, and that by reason of a certain clause in the contract, referred to in the opinion, the paper which purported to be a contract for the construction of the Dolphin was null and void as such.

Prior to this time I had become aware of the circumstance that the officers of the Department had surrendered to the contractor the reser-

vations upon all of his pending contracts, with the exception of a small sum of about $25,000, which reservations had been provided for as the security of the Government for the faithful performance of the work. At this time there were five contracts pending and incomplete, namely, the contracts upon the three cruisers and the dispatch boat and for the machinery in the Puritan.

In the case of the Puritan the contract had specifically provided that the reservations should not be paid until the contract was completed in all its parts and the machinery should have been in use for three months. It also provided for a sea trial of twenty-four hours before the tenth or last payment upon the contract should be made. In December, 1884, many months prior to the completion of the contract, in view of the fact that a sea trial was not possible, a dock trial was had, not satisfactory to the engineer-in-chief; and thereupon, in January, 1885, when a considerble amount of work, estimated at a probable cost of $26,327, remained to be done in order to complete the requirements of the contract, the sum of $76,225.46, constituting the reservations upon the contract, was paid to the contractor in violation of the specific provisions of the contract.

The circumstances under which the reservations had been surrendered upon the other four contracts were as follows: The contracts had provided that the vessels should be provided with steel shafts. The first of these placed in the Dolphin broke upon her trial trip. It had previously been condemned by the Advisory Board upon the tests made under their direction, and had been put in nevertheless upon the responsibility of the contractor. At his suggestion a modification of the contracts and specifications was made by which iron was substituted for steel in the shafts of the four boats.

Upon the supposition, then, that this change of plan had caused delay in the construction, an opinion was obtained from the Attorney-General that the contracts could be modified so as to surrender the reservations to the contractor. With reference to the Boston, Atlanta, and Chicago, in point of fact, no serious delay in the final completion of the ships could properly have been attributed to this cause. Nevertheless, the reservations were, with the exception of about $25,000, surrendered to the contractor.

By these processes something over the sum of $200,000 of Government moneys had been advanced to the contractor, and all of the five contracts were substantially stripped of the security which by the terms of the contracts was provided.

These acts produced an unfavorable impression upon me, inasmuch as I was unable to see that the grounds upon which these moneys were surrendered were substantial. At the same time, it is proper for me to say that I believe the participation of the officers of the Department therein had been in good faith, and with no expectation that the interests of the Government would be imperiled thereby.

It had for some time been no secret in the Department, as I su quently learned, that the contractor was in financial difficulty, and t departures from the law had been made under the pressure of t circumstances. The assignment of the contractor developed the that he had been carrying an indebtedness of over $2,200,000, largely upon unavailable assets.

The assignment rendered entirely clear the duty of the Government. There was no other course but to take the vessels and complete t This was the wish of the contractor and the duty of the Governı the same time.

Upon the 25th of July I stated the position of the Department in a letter to the assignees, as follows:

> As I view the matter, the rule which governs individuals in these business transactions should govern the action of the Department. At all events, if there is a different rule proper to be applied I am not aware of it. My duty heretofore has seemed to be very simple and plain. It has been to insist upon the strict enforcement of contract obligations, as interpreted to me, without regard to consequences. That is the ordinary plain business method, a departure from which in a public officer can have no justification; and in like manner I know of no reason why the ordinary principle which actuates merchants in dealing with each other, and, in accordance with which generous consideration is extended ordinarily to an unfortunate business associate, should not govern the action of the Department under similar circumstances.

Early in August I stated to them fully the manner in which the four ships should be dealt with, with which they were entirely satisfied.

On October 1st I embodied (having meanwhile disposed of the more important matters of the other boats in process of construction, the Boston, Atlanta and Chicago) my views with regard to the Dolphin in a proposition, the substance of which was that the Government should take her and should pay the contract price for her when made equal in all respects to the contract requirements. If the contractor should be able to show that this had been done, he should recover the balance of the money; if not, there should be reserved from the judgment a sufficient sum to make her equal to the contract requirements. By so doing I have taken the responsibility of placing the Government in the position which it ought to assume. If the ship is the Government's design, the contractor should be held to correct construction, but not for the performance of the ship. If the design is the contractor's, as in England is often the case, then the contractor may properly be held for both. The contracts should be clearly expressed to this effect.

The Dolphin case remains, therefore, to be disposed of upon proof to be supplied to the court upon these points.

I have, in addition, taken measures to ascertain and settle the question as to her strength. If she proves well built in that regard the other matters of dispute can be, I think, settled by agreement or arbitration out of court.

As to the Boston, Atlanta, and Chic , enth clause of the con-

tract provided for the contingency of work being stopped upon them, and the provisions of the contract have been pursued; the ships have been taken possession of by the Government; an inventory of the amount of work performed has been made; the valuation also had, and the Government is proceeding to complete them where they stand in the yard, employing the foremen and force of the contractor.

It is of no use to discuss the character of the boats, their merits or demerits. Under the present circumstances all that the Government can do from a business point of view is to complete them. Whatever they turn out to be they will demonstrate in practice.

PROMOTIONS IN THE SERVICE.

The rewards which the service affords at the present time for the more meritorious officers are inadequate. I commend to your attention the considerations advanced upon the subject of promotion in the service by my predecessor in office in his annual reports of 1882 and 1884. Some remedy should be found for the long delay in promotions and the inequality therein which will result from the working out of the present laws. I shall hereafter make it the subject of special attention, in the hope that some method may be found by which, without additional burdens to the Treasury, the rewards for superior attainments in the service may, in time of peace as in war, be distributed by some just system, and the tone and spirit of the service be kept up.

FUTURE APPROPRIATIONS FOR NEW SHIPS.

A most intelligent effort has been made by Congress within the last three years to gather information upon the subjects of heavy ordnance and war ships, and as to the best method of developing in the United States the industries connected therewith. The elaborate and most valuable investigations of the Gun Foundry Board, and the more recent ones of the committees of the two houses and of the Fortifications Board in the present year, will place the country in the possession of the latest information, and, I doubt not, mark an era in the history of legislation upon these subjects.

I refrain, therefore, from any discussion at the present time of the subject of future appropriations for material of war. Indeed, so many and most formidable implements of war have become now so well established and approved that at the present time any movement on the part of our Government in any direction would, if intelligently executed, prove of incalculable importance to our naval strength and power.

Cruising ships, however, we must have, unless the policy of continuing repairs upon worthless ships is to continue, or unless we are to abandon the national duty of affording the security and protection of our presence and power throughout the world wherever our people sojourn.

I commend to your consideration the recommendations of the Bureau officers of the Department upon these subjects.

In order to illustrate the importance attached elsewhere to the torpedo-boat as a branch of naval warfare, I insert a list of those possessed and in process of construction by other countries. The United States has none:

Nation.	In service 1884.	Ordered for 1885.	Remarks.
England	129	55	Does not include those in colonies.
Germany	11	61	Fleet to be increased to 150 of first class.
France	82	77	Fleet to number 283 in all.
Russia	131	14	Fleet to number 180 in all.
Austria	14	2	Fleet to number 70 in all.
Denmark	12	....	To build 21 more.
Greece	37	....	
Italy	53	18	To build 100 more.
China	5	10	One of these is to be 164 feet long.
Japan	....	....	The largest boat under construction, 166 feet long, is now building for Japan by Yarrow & Co. Others are building in Germany.

THE FLEET AT THE NEW ORLEANS EXHIBITION.

Upon the occasion of the recent exhibition at New Orleans the North Atlantic Squadron was directed by my predecessor in office to visit the harbor of New Orleans; and the admiral in command was authorized to expend a very limited sum, which amounted to about $400, in receiving and extending the hospitality of the ships to visitors entitled to official recognition. This sum was subsequently checked against the admiral in the Treasury Department; but at my request the payment of his salary has not been stopped, awaiting an application to Congress for authority to pay the amount. Without intending to question the correctness of the action of the Treasury Department, it seems quite clear that the amount should be allowed and appropriated for.

In connection with this subject it is proper to call attention to the fact that in a time of peace the Navy is the agency through which largely national courtesies and hospitalities are exchanged throughout the world. It is somewhat the custom of other nations to avail of their navy as a means of creating and extending national good-will, and fleet officers are frequently supplied by their Governments with reasonable means for reciprocating official courtesies. Without some such provision these burdens would fall sometimes with undue severity upon officers of small means.

It has been the custom of the Department to reimburse them certain expenditures in those lines, but under recent rulings of the Treasury Department it may be necessary to discontinue this custom.

It may well be considered by Congress whether a small sum may not judiciously be allowed annually for this purpose, to be accounted for under direction of the Secretary. From three to five thousand dollars would probably be in excess of the annual amount to be required. It is a small sum, but the burden falls upon fleet commanders largely, of which there are but five, who are thus pe 'nished for their high rank and station of (

THE ORGANIZATION OF THE DEPARTMENT.

Thus closes the résumé of the proceedings of the Department for the fiscal year, most of which occurred under my predecessor in office. Before formally closing this annual report I feel called upon to express for such discussion and consideration as they may seem to warrant my first impressions of the difficulties and drawbacks under which the Department labors.

It must be evident that there is something radically wrong with the Department. The universal dissatisfaction is the conclusive proof of this. It is expressed to me by influential members of both political parties, and quite universally by the naval officers, coupled with the hope and expectation that some remedy may be found and speedily applied. Placed temporarily in charge of the interests of the service, it forces itself daily upon me for consideration.

It is desirable to discriminate at the outset between the naval service and the Navy Department.

Our naval service, numbering altogether, including line officers, engineers, chaplains, pay officers, naval constructors, &c., on the active list, 1,590, consists of a body of accomplished men representing a high standard of personal character, who are deservedly respected and honored throughout the world.

This, unfortunately, cannot be said with equal justice of the Navy Department, and whatever dissatisfaction the country has ever experienced with the naval arm of our Government will be found to have had its origin, not in the naval service, but in the naval administration, and even there dissatisfaction should be limited to certain branches only of the business of the Department.

Historically it is a fact that up to the time that the present Bureau system was created, in 1842, and for some time thereafter, the American Navy, though inferior in numbers to the navies of some other countries, was as formidable as any for its tonnage, and seems to have contributed to, and appropriated improvements in, the art of naval warfare as largely and as rapidly as any other naval power.

During the thirty years between the close of the war of 1812 and the commencement of the Mexican war, our naval force increased fifty-fold and the navies of no other power were superior to it except in the number of their vessels. "As respects the navies of this hemisphere, it was supreme, the united marines of all the rest of this continent being unable to contend against it for an hour."*

Prior to 1842 the business of the Department had been managed by a Board of Naval Commissioners, and the result of my reading leads me to the conclusion that while the affairs of the Department were intelligently administered so far as the general scope of the conduct of its affairs was concerned, yet the system failed in executive force.

* Cooper's Naval History: Preface.

In 1839 Congress called upon the Secretary of the Navy, by resolution, to propose a plan of reorganization, embracing "a division of the duties performed by the Board of Naval Commissioners and their assignment to separate Bureaus." In compliance with this resolution the Secretary reported in December, 1839, a system, and in 1842 Bureaus with independent heads were first established. It was quite evident that with the application of steam to naval vessels a new problem, and one which has been greatly multiplied since by the constant progress of the arts, had been brought to the Department for solution. The Secretary says:

Should the introduction of steam as an auxiliary to naval warfare be sanctioned by the results of experience, it must be obvious that new and very important duties will devolve on the Secretary of the Navy, rendering the aid of professional science and experience still more indispensable in the administration of the Department.

Up to that time a Naval Commission, composed of naval officers, without responsible executive heads subordinate to them, had resulted for a long time satisfactorily, but finally had failed with the accumulation of labor and with the problems which science had thrown upon the Department.

If one should take up the subject in this form and consider, in the first place, what business does the Department transact? what should be the organization for its proper disposition? and compare it with the organization as it exists here and elsewhere, perhaps some light may be thrown upon the difficulties encountered under the present form of administration.

The natural division of the work of the Department is into three branches:

First. The Department having to do with the personnel and the fleet. This covers the enrollment, service, detail, uniform, organization, and discipline of the personnel; of the movements and command of fleets and vessels when commissioned; and this is properly the military branch of the Department.

Second. The Department of Material and Construction. This covers the construction, repair, and care of vessels before commissioned; their armament and equipment, including military stores (but not provisions and clothing), as well as the management and maintenance of dockyards, their buildings, machinery, and their civil establishment.

Third. The Department of Finance and Accounts, this covering contracts and purchases of all naval stores, flags, coal, stationery, and care of storehouses, &c.

This division of functions is not the one existing. It properly separates, however, the business of the Department for purposes of analysis and consideration. The functions of these last two departments are largely civil.

It is in these last two branches of the service that the difficulties arise. The first or military branch may be placed out of consideration, for the

luties of that have been satisfactorily performed. With reference to the ast two branches note that it is the consideration of any ordinary busiıess, and the first requisite to successful transaction of any business is a proper system by which responsibility is lodged in its appropriate place. This division, according to the functions, is one that is, in general, common to the systems of England, France, and Germany. There will be found variations peculiar to each, but there is a substantial agreement n the distribution of functions such as I have indicated.

In the first place, there is the financial department. The last of those ove named where the ordinary purchasing, the payment of bills, the iditing, the general system of accounting, &c., are brought under one ead. It is sometimes placed in civil hands and the naval service reieved from any responsibility with reference to it. If a certain class of oods, or a certain article, is required by a branch of the service a requisition is made upon the financial department; there the accounts are kept, the distribution and disposition of the property accounted for; purchases are made largely by contract, and for this class of business a person is selected having business capacity. The inspection of goods and material is by the department for which they are intended. This seems to be a proper distribution or location of these functions.

Here this business is scattered through all the Bureaus.

I have very scant means of investigating, but have conducted a few nquiries into the workings of the system in vogue with us for the purpose of informing myself as to its merits, with results such as one might anticipate.

For the security of the public it is provided by law that the purchases of the Navy Department shall be by contract, after advertisenent, and shall go to the lowest bidder; that only "regular dealers" shall be dealt with by the Department, which has been interpreted to ean persons whose occupation it is to deal in such articles with the eneral public. The contract system can be dispensed with only when here is an emergency certified to by the Bureau officer for the immeliate purchase, doubtless largely intended for a time of war. Without ı efficient head to establish a system and attend to its proper enforcent in the matter of purchases, one would expect to find that order of things which has heretofore brought grave scandals upon the Department, namely, large private purchases where contracts were intended by law, and the business falling into the hands of naval contract brokers to the exclusion of regular dealers in the articles. These ibuses (quite inevitable in the absence of a proper system) were investigated and exposed by Congressional committee years ago; but by resent investigations I find the same order of things largely existing lown to a recent date, and the same men named in the Congressional report holding substantially the same relation to the Department as before, and with the same scandalous results.

The open purchases of the Navy Department for the year en June 30, 1885, amounted to $841,285.84 while the purchases by con amounted to only a little over a million. A large proportion of the ope purchases consisted of articles of either comparatively small value, more or less difficult of classification; but $138,000 of the amount spent by the seven Bureaus, each acting independently of the o coal bought, not in one lot, but at 166 several open purchases (this not include coal bought by ships on foreign stations); 299 differ open purchases of stationery were made by eight different Bur us; $121,315.66 was spent for lumber and hardware by six Bureaus in 499 separate open purchases. Seven Bureaus spent $46,000 for oils and paints in 269 separate purchases; 117 different open purchases of iron and steel were made at an expense of $41,524.48; $68,881.59 was spent for hemp and cordage in 45 different open purchases. Eight Bureaus supply stationery to ships; three Bureaus supply ships with lamps and lanter To the same ship one Bureau supplies electric lights and the light for general illuminating purposes; another supplies electric search lights, and a third oil and light for the engine and fire rooms.

These facts are taken from the records of the year ending June 30, 1885, and its showing is more favorable than that for the previous year. I do not question the good faith of the Bureau officers through whom these purchases were made, nor that the purchases were for the most part honestly made. The abuses inevitable under a system of such divided responsibility for the discharge of duties which are only incidental to the general business of the Bureau does not necessarily imply fraud or even indifference to the interests of the service.

But under a system in which these purchases are a mere incident to their general business, it is inevitable that they should be neglected, and the suggestion I make is that they are not properly classified and placed under the proper management and control; for, if the list of persons is examined from whom these purchases are made, there is an astonishing repetition of the names of naval contract brokers, not engaged in a regular business, and whose dealings with the Department caused grave scandals many years since. These purchases have to be made in this form under a certificate made by the Bureau officers, that there is a necessity for the immediate purchase of the articles, which, when used to such an extent as is exhibited under these investigations with reference to standard articles like coal, stationery, lumber, oil, and paints, and articles of that character, simply indicate that the most convenient and not the most economical method of making purchases is resorted to. In some cases private (in distinction from public and open) competition is resorted to, and in some cases short advertising.

Illustrations of a rather extraordinary character of the resort to this certificate of necessity for immediate purchases as a convenience appear among these records.

In the summer of 1883 an order was th of can-

was to a person who was not a dealer in the article and at a time when there is the usual supply of canvas on hand.

I er an order made by Secretary Thompson in 1877 it was under- that the limit of any single purchase under a "certificate of nec- y" was $500. For purchases involving a larger amount resort be had to the ordinary contract system. Several months were in the delivery of this $61,000 worth of canvas and the bills ade out in sums of less than $500 each. The "certificate of ty" accompanied each one, and in that form the bills passed the Tr y Department.

Tw or three of these bills, with the Bureau officer's certificate of ne- y upon them, would sometimes be dated and presented on the .

During the same year coal was purchased by different paymasters from the same person on or about the same days, deliverable at the very same place, of like quality and character, but at prices differing from 50 to 65 cents a ton.

It is idle to suppose that abuses of the character I have glanced at prevented merely by a change in the personnel of the Depart- . It is the system that is vicious.

The business of the Bureau of Equipment and Recruiting at the time uses here referred to occurred was under the charge of a distin- g naval officer of unquestioned integrity and conspicuous execu- tive ca city. It is due to each of the chiefs at present discharging the duties of the various Bureaus that I should express my conviction that they have all labored conscientiously to do what in them lay to protect the service from the unsatisfactory results of a system which they can neither reform nor control.

I h Bureau in the matter of purchases being practically independent every other, and charged with duties to which these are generally bordinate; with no immediate responsibility to any common head, it not only not surprising, but it is inevitable that their purchases uld be made without the precautions and the judgment and the ty which might be expected if that class of duties were confided an individual selected for the purpose, and upon whom its entire onsibility could be concentrated. With such a concentration of onsibility, the financial operations of the Department would all ter at a single point; a system of books would be kept that would at a glance all the financial transactions of the Department, and t same time would establish what is sadly lacking at present, an bit of all the property of the Department for which some one would countable.

I e en measures to obtain a complete inventory of the stock on in our various navy-yards and stations. It is the first that has made in seven years. In view of the defective system under which

the Navy Department has been allowed to drift during the last twenty years, I was not greatly surprised to discover that the stock on hand fails to agree with the amounts shown by the books of the Department. In some cases it is largely in excess, in others there is a deficiency.

The discrepancy can only be explained by the absence of a proper system of accountability. Taking for an illustration the article of canvas, of which the Navy is a large consumer. When it is taken from the storehouse upon requisition the amount is checked off on the books. Here accountability practically ceases. What of it, if any, is not used, remains in the sail-loft. What finally becomes of it, sooner or later, it becomes difficult, if not impossible, to ascertain. Charges of its being pilfered and redelivered to the Department by contractors, in collusion with the clerks, have been made from time to time. The remnants, if returned, have not always been entered on the books. This necessarily left in store a surplus beyond what the books called for, constituting a temptation which it is not wise for any Government to offer. Were this business placed under a single and competent head, with entire responsibility, discrepancies like these, which, if known, would be fatal to the credit of any commercial house, could only occur in rare cases, nor then without blasting the character of the responsible officer.

It is probable that a person equipped with the business training and experience requisite for the effective discharge of such a trust might more readily be selected from civil life than from the naval service. Such has been the experience and the practice of the great naval powers of the world. In England the class of duties to which I have referred is devolved upon the financial secretary, who is selected by the first l of the admiralty, and who is required to be a civilian and a meml of Parliament. He sits with the Admiralty board, and is expected to ent and defend the estimates of the Admiralty in the House of Comm and upon him the Government depends mainly for the direction and trol of this branch of the Department's business.

From the consideration of this branch of the service two or things would seem to appear. In the first place, that the present sys has worked badly, even down to the present time; in the second plac that any proper system would throw this work together under o head; and, in the third place, that that is in general the sys adopted by other countries.

Returning now to what I have called the second branch of the functi of the Department, that of material and construction, we encoun difficulties of a yet more serious character. It is here that the De ment has most lamentably failed. The rapid advance of the art naval warfare and the singular fertility of human genius in devis new and ever more formidable implements of destruction are rend the problems of this branch of the public service daily more compli and difficult. At the present moment it must be conceded that we

nothing which deserves to be called a navy. The highest official authority in our service said in 1876:

> There is no navy in the world that is not in advance of us with regard to ships and guns, and I, in common with the older officers of the service, feel an anxiety on the subject which can only be appreciated by those who have to command fleets and take them into battle.

And so recently as 1883 the same distinguished authority stated that it was universally admitted "that we have no navy either for offense or defense."

The country has expended since July 1, 1868—more than three years subsequent to the close of the late civil war—over seventy-five millions of money on the construction, repair, equipment, and ordnance of vessels, which sum, with a very slight exception, has been substantially thrown away; the exception being a few ships now in process of construction. I do not overlook the sloops constructed in 1874 and costing three or four millions of dollars, and to avoid discussion they may be excepted also. The fact still remains that for about seventy of the seventy-five millions of dollars which have been expended by the Department for the creation of a navy we have practically nothing to show.

It is questionable whether we have a single naval vessel finished and afloat at the present time that could be trusted to encounter the ships of any important power—a single vessel that has either the necessary armor for protection, speed for escape, or weapons for defense. This is no secret; the fact has been repeatedly commented upon in Congress by the leading members of both parties, confessed by our highest naval authorities, and deprecated by all. Such is not the kind of navy which this country, with its extensive coast line, its enormous territorial area, and incalculable commercial resources, requires, nor such as it is entitled to have. This country can afford to have, and it cannot afford to lack, a naval force at least so formidable that its dealings with foreign powers will not be influenced at any time, nor even be suspected of being influenced, by a consciousness of weakness on the sea. While still striving to build up its merchant marine and to multiply its relations with foreign markets, it cannot be expected much longer to tolerate such expenditures for a navy which could not for a moment defend even its diminutive commerce against any considerable power.

A naval vessel at the present moment is a product of science. Taking the world over, it will be found that each part of her—her armor, her armament, her power, her form, and the distribution of her parts or characteristics—each of these features of the completed vessel is absorbing from year to year the exclusive study of a class of scientific men. And as men of science throughout the world are continually stimulated to new discoveries and inventions, no vessel that can be built can be considered a finality in any particular.

The problem of keeping pace with the march of improvement in these lines of industry is one of incalculable difficulty; and yet unless the

Government is prepared to avail itself promptly of all the improv that are made in the construction and equipment of its ships its ex itures are largely useless.

It is of little service to a nation to have any navy at all un ti a fair expression of the highest scientific resources of its day. destructive power of the modern implements has become so great as t dominate in actual warfare. The bravest and best commander is h less without them.*

For the construction and maintenance of such a navy we have but little provision. To have and maintain such a navy is, I believe, the wish of the country and the duty of the Government.

In order to encounter and deal with this problem other count have made certain important changes in their policy of late y , to which it may be proper to call attention for whatever consideration seems proper.

First, in the matter of the education of their men they have differentiated them and spent money to create in each branch men with the necessary scientific training. In England and France the edu tion of the naval constructor and the designing engineer is, from ginning to end, entirely different from that of a line officer, and highly scientific. Follow the education of a constructing engineer in England. By a competitive examination students are selected for entrance at the naval dock-yards. They become apprentices, and for six years work as such, and become familiar by actual work with machinery and mechanics, attending the dock-yard schools meanwhile. At the end of six years they are eligible for entrance to the Royal Naval College at Greenwich, where they pursue a scientific engineering course for one year, when they are commissioned as assistant engineers and sent to sea; but from this class, at the end of the one-year's course, two are chosen annually by competition, and reserved for higher education at the college. These pursue a further scientific course in marine engineering for two additional years. At the end of this course one year is supposed to be passed at sea, when they become foremen at the Admiralty dock-yards, and are eligible for the positions of draughtsmen and assistant constructors attached to the Admiralty force. Upon graduation they become permanent civil servants, entitled to a pension, with a fixed tenure, and these men, with the naval constructors similarly educated, are to be found not only in the Admiralty, but throughout the private dock-yards

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* The destructive power of the modern implements of war is well illustrated by the battle between the French and Chinese fleets at Pagoda Anchorage, Min River, in August, 1884. There was not sufficient difference in the number and tonnage of the vessels engaged to justify any decided opinion as to the result of the contest. There were nearly a dozen vessels in line or in reserve on each side. Most of the Chinese fleet, too, were of modern construction, but it was not equipped with torpedoes nor machine-guns, besides being in other respects inferior to the French in the destructive power of its armament. Within fifteen minutes after the signal for the attack was given the entire Chinese fleet was disabled, and in less than half an hour all that could be seen of it were hulks in flames or sunken vessels.

and ship-building establishments everywhere in England; and in several notable instances these men have risen to great distinction, with very high social and professional rank, and have contributed greatly to the advancement of the ship-building interests of their country.

In France there is but one corps of construction, called the engineer corps. The education is here entirely separate from that of the line officer, and they are given high rank in the service. The head of the corps ranks with a rear-admiral; he is called the inspector-general. The director of naval construction ranks above a captain and after rear-admiral. Engineers of the first class rank with captains; engineers of the second class with commanders; this is the designing-engineer class, with high scientific training. It is a separate corps from what is called the engineering mechanicians, who have the supervision of engines and machinery on board ships.

In broad contrast with the policy of both the great naval powers here indicated, the only step we have taken for many years to meet the constantly changing exigencies of the service has been to discontinue the special education of engineers. The separate engineer class at the Naval Academy was abolished in 1882, and the man who now graduates from the Naval Academy into the engineer corps will have had no experience in the dock-yard, no familiarity with construction, except such elementary knowledge as he may have acquired in common with a line officer at the Academy. Even his sea service has been in a sailing vessel, where he has been taught the seamanship of a past generation, and he may have never seen a modern engine in his life. Upon graduation, instead of being sent where practical experience in his branch of work can be acquired—to a marine-engine establishment or a ship-yard—he is sent to sea, and it is from this class that designers, who are expected not only to utilize all the latest improvements of other naval powers, but to add to and perfect them, are supposed to be selected. One exception should be noted to this: By the courtesy of the Governments of England and France we are permitted to maintain two students at the Royal Naval College at Greenwich, and two at the French Naval College at Cherbourg. This privilege will doubtless prove an important advantage to us in process of time, though somewhat slowly; and our students are still without the dock-yard experience which theirs enjoy.

In other words, we have traveled in one direction in this regard and other people in another. They imagine that to keep up with one branch of scientific human industry at the present time is sufficient for one man, and that it is necessary to educate to it and to furnish adequate rewards within the line in which talent and science are desired.

The result of this is seen in the fact that while they have been steadily advancing in the arts of naval construction and equipment until there is scarcely a feature of the vessels they are now constructing or a weapon which figures at all conspicuously among the distructive powers of their

armament which is not comparatively a novelty, we stand but little in advance of our position as it was twenty years ago.

We are also called upon to take note of the fact that all the great naval powers appear to have found it to be to their advantage to avail themselves largely of private enterprise in the creation of implements of war. No designing engineer of the English Admiralty has designed an engine for many years. In their stead the private marine-engine builders of the nation, who can produce evidence of adequate responsibility, are invited to compete with each other to produce, for example, an engine that shall be able to accomplish certain defined results, such as a certain amount of power with the greatest economy of weight and space consistent with strength and durability.

The Admiralty designer acts as a critic of the plans, and as general adviser. He is relieved, in a great degree, from executive labor, that he may have time for study and for keeping up with the progress of his art. Having prescribed the general conditions of the proposed engine, his subordinates supervise the construction. To stimulate and encourage the competitors to spare no effort or expense in executing any order that may be awarded them it is usual to offer a liberal premium for every increase of the required power of the machine, and to attach a pecuniary penalty proportioned to the amount it falls short of such required power.

By this process the Admiralty secures for the Government the best results of all the ingenuity and capital that is engaged in this branch of industry throughout the empire, in addition to whatever aid its own trained agents can contribute. In this way, too, every improvement in marine engineering, wherever and by whomsoever made, is pretty certain to be first offered to the Government. For successful competition under such conditions it becomes absolutely indispensable for competing establishments to avail themselves of all the tributary resources of science, while the Government, by turning over such work to private enterprise, secures a maximum of economy and executive force.

It is the tendency of all governmental service to fall into ruts and grooves, for which in the preparation of implements of war there is perhaps no antidote so effective as an appeal, where practicable, to private enterprise.

Indeed, it is to private enterprise that the art of naval warfare is indebted for most of its improvements. It is difficult to name a single component part of a first-class vessel of war to which private enterprise has not made quite the most important contributions. The iron or steel used for her hull and for her armor; her power and the engines by which it is controlled and directed; her revolving turrets; her guns; her projectiles; her explosives; her torpedoes; her search-lights; her steering gear; her wire cordage, are almost exclusively the invention of

private individuals, and are manufactured and supplied by industrial agencies operated mainly by private capital.

By the system I have described the designer is not only relieved from all the financial business with which he is burdened with us, but, what is of incalculable importance, he is assisted in his work by all the great marine-engine designers of the country. They become as effectually his aids and subordinates as if they held their commissions from their Government.

With us, on the contrary, the head of the Bureau of Steam Engineering, upon whom we depend for designs, is selected from a corps which is at present given by the Government only an elementary training in the science of engineering. He is at once loaded down with the distracting executive work of construction. Having the charge of a multitude of shops in the various navy-yards, he must look after a great variety of contracts, purchases, and so on. In addition to all this, for which of itself few men are equal, he is expected to design the most complicated machinery and give his country the benefit of the daily improvements in his art. It is needless to say that to such a task no man is equal.

The policy of enlisting private enterprise in the work tends to the creation and development of important branches of industry within the country. The resources of our country, its ingenuity and enterprise in any line of human endeavor, when called out, are unexcelled by any nation or people on earth.

If the $75,000,000 spent since 1868 by our Government had been used to stimulate competition among our people in the production of modern ships of war, it is quite fair to assume that the activities and agencies at the disposal of the Government would have been by this time entirely adequate to its needs. It has been wasted by Government agencies upon worthless things. The invention of the country has been discouraged. The Hotchkiss gun now commanding the widest attention, the manufacture of which is becoming an important industry in France, was the product of American invention, which, when ignored and rejected by Government agencies here, found elsewhere its field of development. Ericsson, whose name will always be one of the great ones of our time in history, works now at the age of 83 without encouragement or notice at the great problems of naval warfare, and is receiving more attention and greater encouragement from other Governments than from our own. Examples might easily be multiplied.

Suffice it to say our Government has placed itself in no relation to the inventive genius of the country, and is without the rich fruits which such a course would bring to it.

Another distinction to which attention may properly be called between our system and that in general use elsewhere is as to the manner in which the general policy of the Department is shaped and directed. At the top of the system there should be wise general direction. After

you have freed your technical, scientific men from unnecessary burdens, put the finances where they will be well handled in a business way, freed your designers largely from the executive work, so that they are enabled to put the Department in the way of producing advanced products (appropriating, adapting, and inventing new and improved methods in their various lines), it is of the first importance that the system should center in a wise and judicious and capable directing power, for there is necessarily the daily decision to be made of what shall be done in any particular line.

With reference to a naval vessel, the first step is the consideration of the direction in which the nation shall move amid the conflicting opinions of disputants. All the difficult problems in the construction of a vessel of war present themselves and must be settled before the construction is commenced. Her size, her speed, her armament, her protections; the proportion of displacement which shall be given to each, and her probable cost, are all of them problems of incalculable difficulty, and about which the most competent authorities are usually most diffident in expressing opinions.

For the determination of these questions boards consisting partly of naval officers and partly of civilians are usually constituted. The naval powers of the Old World provide a permanent council or board, whose duty it is to consult with and advise the minister of marine. They are largely freed of executive duties and functions, so that they may have time for investigation and study, and to be thus enabled to take a large view generally of the questions which are involved in directing the course and general policy of the Department.

It occurs to me that the superiority of our system as it existed up to 1842 was in this regard; for it seems that what was done was wisely done. The ships that were built were up to the state of the art at the time. There was the necessary intelligence directing the movements of the Department; but they failed in executive business capacity, and the Bureau system was devised to remedy this. It was supposed at the time, as the record shows, that the Bureau chiefs would be able to sit in consultation with the Secretary and that the Department would not lack intelligent guidance. But the inevitable result of throwing large executive duties upon any man is to disqualify him for council. At the present time this function is not performed at all. The Secretary may at once be eliminated from the problem. A civilian ordinarily, not skilled in the art of war, nor having the technical knowledge with reference to its implements; having no personal staff, his separate office force consisting, as estimated for and appropriated by Congress, of but one stenographer, one clerk, and three messengers—all the other force having general clerical work. Thus it happens, as it has happened for the last twenty years, that the Department drifts along doing without consideration whatever is done and with no intelligent guidance in any direction.

If illustration should be thought desirable of the fact that the De-

partment lacks wise directing power, the unwisdom of its expenditures, the fact that it has steadily gone behind in the race, while its Bureau officers are known to be able and experienced men, may properly be cited.

My experience of the manner in which important decisions are necessarily made by the Secretary, without opportunity for proper deliberation and intelligent advice, leads me to say without hesitation that the follies of the Department are largely attributable to this. Take the "Omaha" for an example. She has been rebuilt within the last four years, at an expense of $572,000. It was an act of the greatest folly. She is a repaired wooden vessel, with boilers, machinery, and guns, all of which would at the time have been sold for what they would have brought by any other nation on earth. In the event of a war she can neither fight nor run away from any cruiser built contemporaneously by any other nation. Her rebuilding cost the full price of a modern [illegible]l ship of her size and all modern characteristics.

Now, if one should seek to ascertain who is responsible for the decision [illegible]t the "Omaha" should be rebuilt, it would be found that no one so [illegible]d, after discussion and an intelligent knowledge of facts. The [illegible]ef constructor will deny responsibility except for the survey; the [illegible]neer-in-chief the same; and the Secretary of the Navy, if he [illegible] be able to recall the circumstances, would doubtless remember [illegible] he was advised that she needed general repairs and rebuilding, and gave the orders in ignorance of the probable result of his decision.

It may be said that the Secretary should call the chief constructor and designing engineer and the other Bureau chiefs and ask them to sit down and discuss with him the problems of the Department. They would be very competent to assist him in that capacity, but, in the first place, they are too fully occupied with executive work to leave them any time for such investigations as could be of any service to the Secretary, and, [illegible] the second place, the responsibility is not placed upon them.

The most that can be said is that the Secretary might enforce the [illegible]cessary aid in an individual case, but it would not be possible to ex[illegible]d it much further.

I find myself forced, therefore, to the conviction that everything con[illegible]ted with the construction and equipment of our Navy is done with [illegible] little deliberation, and that under the present organization of the [illegible]tment this cannot be otherwise. I have occasion to know that the [illegible]unts found to have been expended upon the "Omaha" and upon the [illegible]hican" surprised no persons more than the Bureau officers who had en[illegible]ged upon the work. Seeing the ill-advised and inconsiderate [illegible] in which important steps are necessarily taken by me under the [illegible]t system, I feel certain that a similar record of mismanagement, of [illegible]eful expenditure, of injudicious and ill-advised disposition of public [illegible]ys might be made by any Secretary under the present system. Nor [illegible] I undertake, with the hope of any substantial success, to prevent

entirely the mismanagement which has so long been the reproach Department. As in the English service, and notably in the Fre German, the Secretary should be provided with a board or bo consultation, consisting of naval officers and experts, most of comparatively free from executive duties, whose duty it should assist him in solving the technical problems of the Department.

The creation of the Naval Advisory Board was an attempt to su this want to the Secretary in the matter of the consideration of the ships authorized in 1883. It was, I have no doubt, a benefit in respects and a substantial aid to the Secretary. I think it unfortu that the intention of the law, as it is now understood by both the Ad visory Board and the Bureau officers after a general consultation wit me, was not carried out. If they had remained with an advisory func tion merely, preparing plans, consulting over and advising tary with regard to what the ships should be, examining and ins the work as critics and independent advisers, leaving the respo ty for the work with the Bureaus, instead of taking into their own ha the executive function and practically superintending and doing work, it would, I think, have worked in a more satisfactory manner to the Department and the service.

My brief experience in this Department has satisfied me that wl ever changes in its organization may be desired, it is of first nec to separate, as much as practicable, the work of direction and del ation from the details of execution; in other words, that there sho be in the construction of a navy, as in every other kind of bus a proper distribution of labor.

It is proper to say that many improvements in the present or tion may be made by the Secretary without additional legislation; a to the extent to which, after full consideration and discussion, cl will seem to be judicious, they will be undertaken. In the mat of obtaining designs for ships and determining the form in which pro s shall be made to private ship and engine builders, he is allowed sonable latitude. Indeed, prior to the war the engines of a large proportion of the naval vessels were designed in various establishments, in answer to proposals calling for general requisites of machinery. I have deemed it wise to avail myself of these discretionary powers to accumulate for the instruction and use of the Department in preparing the plans of the ships about to be advertised the latest designs, so far as possible, of eminent naval constructors of other countries; but no power is lodged with the Secretary to make any effectual changes in the organization of the Department itself, or do more than redistribute somewhat the functions among existing Bureau chiefs.

The system of organization indicated herein begins with the Secretary (who occupies a position at the confluence of all the powers confided to the Department) and supports him with some aids or advisers in such

ıber and of such character as shall seem judicious; (an Assistant ·etary of the Navy would seem to be an essential feature.) Then es one person at the head of each of the three natural divisions of e functions of the department, which may be stated to be finance, ruction, and *personnel;* then subdivides the business of each division according to the subject-matter with which each deals. Thus the division of material and construction would necessarily have a subdivision or bureau for engineering, one for construction, one for equip-, and one for ordnance.

At present the four heads of these bureaus, instead of co-operating, work ıdently of each other and not always in harmony in producing ›ir respective parts of a completed ship. After the "Omaha" had ən commissioned and was ready for sea, it appeared that the several t eaus working independently upon her, had between them so com-ıtely appropriated her space that they had left her coal-room for not e than four days' steaming at her full capacity. Each bureau, too, s it necessary to maintain its separate shops in the several navy- each with a separate organization of foremen, quartermen, lead- ın, &c., so that shops doing precisely the same class of work—car- er-shops and machine-shops, for instance, are commonly duplicated sometimes triplicated in the same navy-yard with a corresponding ılti icity of foremen and organization expenses—a state of things h, der the present organization of the Department, it is almost im to correct.

If such an organization should commend itself to the law-making power and be once tried, I feel confident it would be of great benefit to the country.

It calls for no additional expenditures.

Our present departmental force is more than adequate to our needs if rearranged and systematized. Our policy as a nation is such as not to require a great naval force, but we need wisdom in expenditures and a force adequate for the enforcement of our views of right and justice.

To secure these results a reform in our organization is indispensable.

Very respectfully,

WILLIAM C. WHITNEY,
Secretary of the Navy.

APPENDIX.

No. 1.—ESTIMATES, SECRETARY'S OFFICE, ETC.

...ates of appropriations required for the service of the fiscal year ending June 30, 1887, for the Navy Department.

Detailed objects of expenditure, and explanations.		Estimated amount which will be required for each detailed object of expenditure.	Amount appropriated for the current fiscal year ending June 30, 1886.
OFFICE OF THE SECRETARY.			
...ary		$8,000 00	
...clerk		2,500 00	
...sing clerk		2,250 00	
...erks of class four		9,000 00	
...rk of class four, in charge of files and records		1,800 00	
...clerks of class three		4,800 00	
...enographer		1,600 00	
...enographer		1,400 00	
...erks of class two		2,800 00	
...rks of class one		7,200 00	
...lerks at $1,000 each		4,000 00	
...legraph operator		1,000 00	
...essengers at $840 each		1,680 00	
...assistant messengers, at $720 each		2,160 00	
...essenger boys, at $420 each		840 00	
...essenger boy		240 00	
...laborers		1,980 00	
...rk of class two, for Inspection Board		1,400 00	
...borer for Inspection Board		660 00	
...rk of class two, for Examining and Retiring Board		1,400 00	
...rk of class one, in care of library		1,200 00	
...sistant messenger, in care of library		720 00	
		58,630 00	$58,630 00
...tant Secretary of the Navy, submitted, $4,000.			
CONTINGENT EXPENSES.			
...ationery, furniture, newspapers, plans, drawings, drawing mate... freight, expressage, postage, and other absolutely necessary ex...es of the Navy Department and its various bureaus and offices		13,500 00	11,000 00
PAY OF THE NAVY.			
...officers on sea duty, officers on shore and other duty, officers on ...ing orders, officers on the retired list, Admiral's and Vice-Admiral's ...taries, clerks to commandants of yards and stations, clerks to pay...ers at yards and stations, inspections, receiving ships and other ...ls, extra pay to men re-enlisting under honorable discharge, pay ...ty officers, seamen, landsmen, and boys, including men in the en...r's force, and for the Coast Survey Service and Fish Commission, ...men and 750 boys, at the pay prescribed by law		7,129,087 50	6,940,780 00
The above estimate is based as follows:			
...ers on the active list	$3,633,800 00		
...ers on the retired list	811,387 50		
...y officers and seamen	2,509,000 00		
...pay of petty officers and seamen, re-enlisting under ...able discharge, 695, at an average of $100 each	69,500 00		
...secretaries to Admiral and Vice-Admiral	5,000 00		
...lerks to commandants and paymasters, shore sta... and receiving ships	72,800 00		
...lerks to paymasters on cruising vessels	36,600 00		
...al pay of the Navy	7,129,087 50		

Estimates of appropriations required for the service of the fiscal year, &c.—**Continued**

Detailed objects of expenditure, and explanations.	Estimated amount which will be required for each detailed object of expenditure.	Amount appropriated for the current fiscal year.
PAY OF THE NAVY—continued.		
The appropriations for the four items last mentioned have heretofore been made under "Pay, miscellaneous," but they should be under "Pay of the Navy." The estimate is for $183,900, which is about the sum paid for those objects during the last fiscal year. Extra pay or bounty for re-enlisting is authorized by section 1573 of the Revised Statutes. Clerks to commandants of yards and stations and to paymasters are allowed, and their pay is fixed by sections 1386, 1387, 1388, and 1556 of the Revised Statutes. The Secretaries to the Admiral and Vice-Admiral are allowed by section 1367, and their pay fixed by section 1556 of the Revised Statutes. The sums paid to these persons come properly under the head of "Pay of the Navy," and not under a contingent or miscellaneous appropriation. There is an obligation of law to meet their pay by necessary appropriations. The estimates for "Pay, miscellaneous" have been reduced the amount asked for them under "Pay of the Navy."		
The actual increase in the estimate over the amount actually appropriated or expended during the past fiscal year for the several objects embraced under the heading "Pay of the Navy," is $4,407 50.		
PAY, MISCELLANEOUS.		
For commission and interest, transportation of funds, exchange; mileage to officers while traveling under orders in the United States, and for actual personal expenses of officers while traveling abroad under orders, and for traveling expenses of apothecaries, yeomen, and civilian employés, and for actual and necessary traveling expenses of naval cadets while proceeding from their homes to the Naval Academy for examination and appointment as cadets, and for the payment of any such officers as may be in service, either upon the active or retired list, during the year ending June 30, 1886, in excess of the numbers of each class provided for in this act, and for any increase of pay arising from different duty, as the needs of the service may require; for rent and furniture of buildings and offices not in navy-yards; expenses of courts-martial and courts of inquiry, boards of investigation, examining boards, with clerks' and witnesses' fees, and traveling expenses and costs; stationery and recording; expenses of purchasing-paymasters' offices at the various cities, including clerks, furniture, fuel, stationery, and incidental expenses; newspapers and advertising; foreign postage; telegraphing, foreign and domestic; telephones; copying; care of library; mail and express wagons, ferriage tolls, and livery and express fees; costs of suits; commissions, warrants, diplomas, and discharges; relief of vessels in distress, canal tolls, and pilotage; recovery of valuables from shipwrecks; quarantine expenses; care and transportation of the dead; reports, professional investigation, cost of special instruction, and information from abroad, and the collection and classification thereof	$273,530 00	$375,(
NOTE.—An estimate for the sum of $183,900 for objects heretofore appropriated for under "Pay, miscellaneous" has been included under "Pay of the Navy," for reasons stated in the note under that head, thus eliminating from the miscellaneous and contingent appropriations items not properly belonging there, and leaving only such for which a specific estimate cannot well be made on account of their contingent nature. Had not this been done, an estimate of from $450,000 to $460,000 would have to have been made under "Pay, miscellaneous." The appropriations for this purpose for the last two or three fiscal years have been entirely inadequate, and the deficiencies range from $50,000 to $75,000 each year.		
CONTINGENT, NAVY.		
For all emergencies and extraordinary expenses, arising at home or abroad, but impossible to be anticipated or classified, exclusive of personal services in the Navy Department or any of its subordinate bureaus or offices, at Washington, D. C.	10,000 00	20,(
PRINTING AND BINDING.		
Printing and binding for the Navy Department and its various branches, to be executed under the direction of the Public Printer	63,000 00	59,(

Estimate of the amount required to pay the officers of the United States Navy for the fiscal year ending June 30, 1887.

Grade.	Sea duty.			Other duty.			Waiting orders.		
	Number.	Pay per annum.	Total.	Number.	Pay per annum.	To	Number.	Pay per annum.	Total.
Admiral				1	$13,000	$13,000			
Vice-Admiral				1	8,000	8,000			
Rear-admirals	3	$6,000	$18,000	4	5,000	20,000			
Commodores	3	5,000	15,000	9	4,000	36,000	3	$3,000	$9,000
Captains (chiefs of Bureau)				3	5,000	15,000			
Captains	9	4,500	40,500	25	3,500	87,500	8	2,800	22,400
Commanders (chief of Bureau)				1	5,000	5,000			
Commanders	22	3,500	77,000	48	3,000	144,000	14	2,300	32,200
Lieutenant-commanders:									
After 4 years	19	3,000	57,000	23	2,600	59,800	14	2,200	30,800
First 4 years	8	2,800	22,400	9	2,400	21,600	1	2,000	2,000
Lieutenants									
After 5 years	119	2,600	309,400	89	2,200	195,800	12	1,800	21,600
First 5 years	16	2,400	38,400	15	2,000	30,000	1	1,600	1,600
Lieutenants, junior grade:									
After 5 years	31	2,000	62,000	21	1,700	35,700	4	1,400	5,600
First 5 years	13	1,800	23,400	9	1,500	13,500	1	1,200	1,200
Ensigns:									
After 5 years	42	1,400	58,800	22	1,200	26,400	3	1,000	3,000
First 5 years	94	1,200	112,800	15	1,000	15,000	11	800	8,800
Naval cadets, undergraduates	67	950	63,650				7	500	3,500
Medical directors									
Chief of Bureau				1	5,000	5,000			
After 20 years, date of commission as surgeon				12	4,000	48,000	2	3,000	6,000
Medical inspectors:									
Fleet surgeons	5	4,400	22,000						
After 20 years, date of commission as surgeon				9	4,000	36,000	1	3,000	3,000
Surgeons:									
Fourth 5 years after date of commission	7	3,700	25,900	6	3,600	21,600			
Third 5 years after date of commission	5	3,500	17,500	2	3,200	6,400	2	2,600	5,200
Second 5 years after date of commission	4	3,200	12,800	7	2,800	19,600	2	2,400	4,800
First 5 years after date of commission	10	2,800	28,000	5	2,400	12,000			
Passed assistant surgeons, after 5 years from date of appointment	31	2,200	68,200	26	2,000	52,000	6	1,700	10,200
Assistant surgeons:									
First 5 years after date of appointment	4	1,700	6,800	10	1,400	14,000			
Not in line of promotion	1	1,700	1,700	1	1,400	1,400			
Pay directors, after 20 years from date of commission				13	4,000	52,000			
Pay inspector									
As chief of Bureau				1	5,000	5,000			
Fleet paymasters	4	4,400	17,600						
After 20 years from date of commission				5	4,000	20,000	3	3,000	9,000
Paymasters:									
Fleet paymasters	2	4,400	8,800						
After 20 years from date of commission	2	4,200	8,400	5	4,000	20,000	3	3,000	9,000
Fourth 5 years after date of commission	5	3,700	18,500	5	3,600	18,000	3	2,800	8,400
Third 5 years after date of commission	3	3,500	10,500	3	3,200	9,600	2	2,600	5,200
Second 5 years after date of commission	5	3,200	16,000	7	2,800	19,600	2	2,400	4,800
First 5 years after date of commission				1	2,400	2,400			
Passed assistant paymasters after 5 years from date of appointment	6	2,200	13,200	11	2,000	22,000	10	1,700	17,000
Assistant paymasters:									
After 5 years from date of appointment	7	1,900	13,300	7	1,600	11,200	3	1,200	3,600
First 5 years from date of appointment				2	1,400	2,800			
Chief Engineer, chief of Bureau				1	5,000	5,000			
Chief engineers:									
Fleet engineers	5	4,400	22,000						
After 20 years from date of commission				20	4,000	80,000	2	3,000	6,000
Fourth 5 years after date of commission	5	3,700	18,500	6	3,600	21,600			
Third 5 years after date of commission	4	3,500	14,000				3	2,600	7,800
Second 5 years after date of commission	3	3,200	9,600	6	2,800	16,800	5	2,400	12,000
First 5 years after date of commission	5	2,800	14,000	4	2,400	9,600			
Passed assistant engineers:									
Fourth 5 years after date of appointment	11	2,700	29,700	13	2,350	30,550	6	1,950	11,700
Third 5 years after date of appointment	14	2,450	34,300	10	2,250	22,500	2	1,900	3,800
Second 5 years after date of appointment	15	2,200	33,000	8	2,000	16,000	2	1,700	3,400
First 5 years after date of appointment	1	2,000	2,000	3	1,800	5,400			
Assistant engineers									
After 5 years from date of appointment	42	1,900	79,800	15	1,600	24,000	10	1,200	12,000
First 5 years after date of appointment	6	1,700	10,200				5	1,000	5,000

Estimate of the amount required to pay the officers of the United States Navy, &c.—**Continued.**

Grade.	Sea duty. Number.	Sea duty. Pay per annum.	Sea duty. Total.	Other duty. Number.	Other duty. Pay per annum.	Other duty. Total.	Waiting orders. Number.	Waiting orders. Pay per annum.	Waiting orders. Total.
Chaplains:									
After 5 years from date of commission	3	2,800	8,400	11	2,300	25,300	5	1,900	[illegible]
First 5 years after date of commission	1	2,500	2,500						
Professors of mathematics:									
After 15 years from date of appointment				4	3,500	14,000			
Third 5 years after date of appointment				3	3,000	9,000			
Second 5 years after date of appointment				3	2,700	8,100			
First 5 years after date of appointment				2	2,400	4,800			
Naval constructor, chief of Bureau				1	5,000	5,000			
Naval constructors:									
After 20 years from date of appointment				3	4,200	12,600			
Fourth 5 years after date of appointment				6	4,000	24,000			
Third 5 years after date of appointment				1	3,700	3,700			
Assistant naval constructors:									
After 8 years from date of appointment				3	2,600	7,800			
Second 4 years from date of appointment				2	2,200	4,400			
First 4 years after date of appointment				4	2,000	8,000			
Civil engineers:									
Third 5 years after date of appointment				3	3,000	9,000			
Second 5 years after date of appointment				7	2,700	18,900			
Boatswains:									
After 12 years from date of appointment	8	1,800	14,400	9	1,600	14,400	8	1,200	[illegible]
Fourth 3 years after date of appointment	1	1,600	1,600	1	1,300	1,300	1	1,000	[illegible]
Third 3 years after date of appointment	1	1,400	1,400	3	1,300	3,900	1	900	[illegible]
Second 3 years after date of appointment	2	1,300	2,600	2	1,000	2,000			
First 3 years after date of appointment	1	1,200	1,200						
Gunners:									
After 12 years from date of appointment	8	1,800	14,400	21	1,600	33,600	4	1,200	[illegible]
Fourth 3 years after date of appointment	1	1,600	1,600	2	1,300	2,600			
Second 3 years after date of appointment	1	1,300	1,300						
Carpenters:									
After 12 years from date of appointment	8	1,800	14,400	14	1,600	22,400	11	1,200	[illegible]
Fourth 3 years after date of appointment	3	1,600	4,800	3	1,300	3,900			
Third 3 years after date of appointment				5	1,300	6,500			
Second 3 years after date of appointment	4	1,300	5,200	2	1,000	2,000	1	800	[illegible]
Sailmakers:									
After 12 years from date of appointment	4	1,800	7,200	8	1,600	12,800	4	1,200	[illegible]
Fourth 3 years after date of appointment	2	1,600	3,200	1	1,300	1,300	4	1,000	[illegible]
Third 3 years after date of appointment				4	1,300	5,200			
Second 3 years after date of appointment							2	800	[illegible]
Mates	9	900	8,100	20	700	14,000	8	500	[illegible]
Naval cadets (under instruction at Naval Academy)				201	500	100,500			

RECAPITULATION.

648 officers on sea duty	$1,[illegible] 00
670 officers on other duty	1,[illegible],850 00
198 officers on waiting orders	346,000 00
1,516	3,466,150 00
357 officers on retired list	811,387 00
74 naval cadets not at Academy	67,150 00
201 naval cadets at Academy	100,500 00
Petty officers, &c.	2,500,000 00
Total amount required	6,945,187.00

Estimate of the amount required to pay retired officers of the United States Navy for the fiscal year ending June 30, 1887.

Grade.	No.	Pay per annum.	Total.
Rear-admirals	44	$4,500 00	$198,000 00
Do	4	3,750 00	15,000 00
Commodores	10	3,750 00	37,500 00
Do	3	3,375 00	10,125 00
Do	2	2,625 00	5,250 00
Captains	3	3,375 00	10,125 00
Do	3	2,625 00	7,875 00
Do	1	2,250 00	2,250 00
Do	2	1,950 00	3,900 00
Do	1	1,150 00	1,150 00
Do	1	900 00	900 00
Commanders	6	2,625 00	15,750 00
Do	1	2,100 00	2,100 00
Do	1	1,750 00	1,750 00
Do	1	1,400 00	1,400 00
Do	1	1,150 00	1,150 00
Do	2	900 00	1,800 00
Lieutenant-commanders	11	2,250 00	24,750 00
Do	1	2,100 00	2,100 00
Do	1	1,900 00	1,900 00
Do	4	1,100 00	4,400 00
Do	1	1,000 00	1,000 00
Do	1	700 00	700 00
Lieutenants	19	1,950 00	37,050 00
Do	2	1,300 00	2,600 00
Do	2	1,200 00	2,400 00
Do	1	900 00	900 00
Lieutenants, junior grade	3	1,500 00	4,500 00
Do	10	1,300 00	13,000 00
Do	3	900 00	2,700 00
Ensigns	7	900 00	6,300 00
Do	2	600 00	1,200 00
Do	1	500 00	500 00
Do	1	300 00	300 00
			00
Medical directors, chiefs of Bureau	2	3,750 00	7,500 00
Medical directors	14	3,300 00	46,200 00
Do	4	3,150 00	12,600 00
Do	1	2,775 00	2,775 00
Do	1	2,400 00	2,400 00
Medical inspectors	3	3,300 00	9,900 00
Do	1	1,300 00	1,300 00
Surgeons	1	2,725 00	2,725 00
Do	3	2,625 00	7,875 00
Do	2	2,400 00	4,800 00
Do	1	2,100 00	2,100 00
Passed assistant surgeons	4	1,650 00	6,600 00
Do	1	1,100 00	1,100 00
Assistant surgeons	3	1,425 00	4,275 00
Do	1	1,275 00	1,275 00
Do	1	950 00	950 00
Do	1	850 00	850 00
Pay directors, chiefs of Bureau	3	$3,750 00	$11,250 00
Pay directors	6	3,300 00	19,800 00
Pay inspector	1	3,300 00	3,300 00
Paymaster	1	2,625 00	2,625 00
Do	1	2,400 00	2,400 00
Do	1	1,400 00	1,400 00
Passed assistant paymaster	1	1,650 00	1,650 00
Do	1	1,500 00	1,500 00
Chief engineer, chief of Bureau	1	3,750 00	3,750 00
Chief engineers	7	3,300 00	23,100 00
Do	5	2,625 00	13,125 00
Do	1	2,400 00	2,400 00
Do	1	2,100 00	2,100 00
Do	1	1,200 00	1,200 00
Passed assistant engineers	1	1,837 50	1,837 50
Do	15	1,650 00	24,750 00
Do	1	1,500 00	1,500 00
Do	1	1,425 00	1,425 00
Do	4	1,275 00	5,100 00
Do	2	1,100 00	2,200 00
Do	1	850 00	850 00
Do	1	400 00	400 00
Assistant engineers	13	1,425 00	18,525 00
Do	7	1,275 00	8,925 00
Do	3	950 00	2,850 00
Do	1	850 00	850 00
Do	1	600 00	600 00
Do	1	500 00	500 00
Chaplains	7	2,100 00	14,700 00
Professors mathematics	3	2,625 00	7,875 00
Do	2	2,025 00	4,050 00
Do	1	1,800 00	1,800 00
Naval constructor, chief of Bureau	1	3,750 00	3,750 00
Civil engineers	2	2,625 00	5,250 00
Do	1	2,250 00	2,250 00
Boatswains	15	1,350 00	20,250 00
Do	1	1,050 00	1,050 00
Do	2	900 00	1,800 00
Do	1	600 00	600 00
Gunners	16	1,350 00	21,600 00
Carpenters	9	1,350 00	12,150 00
Sailmakers	12	1,350 00	16,200 00
Do	1	600 00	600 00
Petty officers, seamen, ordinary seamen, &c.			2,400,000 00
Seven hundred and fifty boys			100,000 00
			2,500,000 00

Pay of clerks to navy-yards and stations, receiving ships and other vessels.

Office, and where employed.	Pay.
PORTSMOUTH, N. H.	
First clerk to commandant	$1,500
Second clerk to commandant	1,200
One clerk to paymaster	1,400
One clerk to paymaster, inspection	1,300
BOSTON.	
One clerk to paymaster receiving ship	1,600
One clerk to paymaster of inspection	1,600
One clerk to paymaster of yard	1,600
One clerk to commandant	1,500
NEW YORK.	
One clerk to receiving ships	1,600
First clerk to commandant	1,500
One clerk to inspector	1,600
Second clerk to commandant	1,200
One clerk to paymaster	1,600
LEAGUE ISLAND.	
One clerk to paymaster receiving ship	1,600
First clerk to commandant	1,500
Second clerk to commandant	1,200
One clerk to paymaster	1,600
One clerk to paymaster, inspection	1,600
NORFOLK.	
One clerk to paymaster receiving ship	1,300
First clerk to commandant	1,500
Second clerk to commandant	1,200
One clerk to paymaster of inspection	1,300
One clerk to paymaster of yard	1,400
WASHINGTON.	
One clerk to paymaster receiving ship	1,300
First clerk to commandant	1,500
Second clerk to commandant	1,200
Second clerk to commandant	1,200
One clerk to paymaster, inspection	1,600
One writer to paymaster's office	1,300
One clerk to paymaster's office	1,600
PENSACOLA.	
One clerk to paymaster	$1,400
One clerk to commandant	1,200
MARE ISLAND.	
One clerk to paymaster receiving ship	1,[illegible]
One clerk to pay office	1,[illegible]
First clerk to commandant	1,[illegible]
Second clerk to commandant	1,[illegible]
One clerk to inspection	1,[illegible]
NEW LONDON.	
One clerk to commandant	1,[illegible]
One clerk to paymaster	1,[illegible]
NEWPORT.	
One clerk to paymaster receiving and training ship	1[illegible]
One clerk to paymaster of station	1[illegible]
One clerk to commandant training station	1[illegible]
One clerk to Naval War College	1[illegible]
NAVAL ACADEMY.	
One pay clerk to paymaster of ships	1[illegible]
One pay clerk to storekeepers	1[illegible]
One pay clerk to Academy	1[illegible]
One clerk to commissary	1[illegible]
KEY WEST.	
One clerk to commandant	1,[illegible]
One clerk to paymaster	1,[illegible]
NAVAL ASYLUM.	
One clerk to commandant	1,[illegible]
One clerk to paymaster	1,[illegible]
FLAGSHIPS, ETC.	
Ten clerks to paymasters of flagships, $1,100 each	11[illegible]
Six clerks to paymasters of 2d rates, $1,100 each	6[illegible]
Nineteen clerks to paymasters of 3d rates, &c., $1,000 each	
Total	10[illegible]

No. 2.—SALE OF OLD VESSELS.

MEMORANDUM CONCERNING THE SALE OF OLD VESSELS UNDER THE ACTS OF CONGRESS, APPROVED AUGUST 5, 1882, *AND MARCH* 3, 1883.

The account of the Hon. William E. Chandler, printed on pages 220–224 of Volume I, Annual Report of the Department, showed a total unexpended balance, November 28, 1884, of the proceeds from the sale of old vessels, on deposit with the Treasurer of the United States, of $105,517.32.

The annexed accounts, A and B (duplicates of those filed and settled in the office of the Fourth Auditor of the Treasury), show his further transactions to the date of his final settlement, and that he turned over, March 6, 1885, the balance to his credit with the Treasurer to the Hon. William C. Whitney, his successor in office, amounting to $56,716.38.

The account herewith, C, of the latter, a duplicate of that filed in the Fourth Auditor's Office, with the necessary vouchers, exhibits his receipts and expenditures of the proceeds from the sale of old vessels, which came into his hands, to the 1st of October, 1885, and shows a balance on deposit with the Treasurer on that date of $8,129.94.

The only other vessels sold, not included in any of these accounts, were the storeship Onward, at Callao, Peru, November 14, 1884, and the tug Rose, at Pensacola, August 12, 1885. Both of these vessels were sold at public auction, under written authority of the President; the former realizing $1,808, which was covered into the Treasury without passing through the hands of the Secretary of the Navy, and the latter $419.25, which has been deposited with the Treasurer, and for which the Secretary of the Navy will be accountable.

JNO. W. HOGG,
Chief Clerk.

NAVY DEPARTMENT, *October* 1, 1885.

A.—*William E. Chandler, Secretary of the Navy, in account-current with the United* *for proceeds of sales of old vessels.*

Date.		Amount.	Tot
	DR.		
1885.			
Jan. 1	To balance on hand from last account-current		$23,7
Feb. 14	To amounts accompanying the accepted bids for the purchase of the undermentioned old vessels under the Navy Department's advertisement, dated January 5, 1885, published in accordance with the fifth section of the act to supply deficiencies, approved March 3, 1883, for proposals which were this day opened and vessels awarded as per statement herewith, viz:		
	Edward Le Bars, New York, purchaser of the U. S. S. Florida, for $42,000; 10 per cent. received with his proposal	$4,200 00	
	E. Stannard, New York, purchaser of U. S. S. Colorado, for $26,700; amount received with his proposal	3,000 00	
			7,2
28	To amount received from Edward Le Bars, by Daniel W. Richards & Co., as balance of purchase-money of the U. S. S. Florida		37,8
	Total		68,7
	CR.		
1885.			
Jan. 26	By bills for tools required in removing old vessels. Paid by Paymaster Edwin Putnam, Portsmouth, N. H., viz:		
	Rider & Cotton, saw-files, voucher 165	53 85	
	Rider & Cotton, round iron, voucher 166	44 19	
	Total amount paid for tools		
	By expense of removing, by breaking up, the U. S. S. Virginia, at the Boston navy-yard, for labor employed. Paid by Paymaster J. F. Tarbell, as follows:		
Jan. 21	Pay-roll for first half of January, voucher 167	1,353 04	
Feb. 6	Pay-roll for second half of January, voucher 168	1,615 91	
17	Pay-roll for first half of February, voucher 169	1,286 48	
	Total expense of Virginia in this account		4,
	By expense of removing, by breaking up, the U. S. S. Colossus at Brooklyn navy-yard, for labor. Paid by Pay Director C. H. Eldredge, viz:		
Jan. 31	Pay-roll for January, voucher 170	202 40	
Feb. 24	Pay-roll for February, voucher 171	61 04	
	Total expense of Colossus in this account		2
	By expense of removing, by breaking up, the U. S. S. Java, at Brooklyn navy-yard, for labor. Paid by Pay Director C. H. Eldredge, viz:		
Jan. 31	Pay-roll for January, voucher 172	5,348 54	
Feb. 24	Pay-roll for February, voucher 173	1,446 54	
	Total expense of Java in this account		6,
	By bills for advertising sale of February 14, 1885, of old vessels, under Department's orders, viz:		
Feb. 11	New York Herald, New York, voucher 174	98 60	
	The Press, Philadelphia, voucher 175	48 20	
	Evening Bulletin, Philadelphia, voucher 176	34 20	
	The American, Baltimore, Md., voucher 177	26 00	
	Commercial Advertiser, New York, voucher 178	42 40	
12	Boston Journal, Boston, voucher 179	22 75	
17	Daily Evening Traveller, Boston, voucher 180	30 67	
	Morning Herald, Baltimore, voucher 181	19 50	
19	New York Republikaner, New York, voucher 182	88 80	
	Marine Journal, New York, voucher 183	27 75	
Mar. 5	The Item, Philadelphia, voucher 184	99 20	
	Daily Evening Post, San Francisco, voucher 185	34 28	
	Vallejo Chronicle, Vallejo, Cal., voucher 186	17 50	
	North American, Philadelphia, Pa., voucher 187	36 60	
	Total amount advertising bills		
5	By balance, on deposit in Treasury of the United States on this date, to be transferred to the incoming Secretary of the Navy		56,71
	Total		68,73

B.—*William E. Chandler, Secretary of the Navy, in account-current with the United States for proceeds of sales of old vessels.*

Date.		Amount.	Total.
	Dr.		
1884. Oct. 1	To balance on hand from last account		$105,517 32
	Cr.		
1884. Oct. 1	By Arthur Peterson, passed assistant paymaster, U. S. N. This amount charged to his account by accounting officers of the Treasury in settlement of previous account of the Secretary of the Navy; the amount having been erroneously disbursed by Passed Assistant Paymaster Peterson		88 80
	By bills paid during quarter for advertising sale of May 3, 1884, of old vessels, viz:		
Nov. 14	National Republican, Washington, voucher 121	$28 50	
21	Baltimore Sun, Baltimore, Md., voucher 122	72 00	
			100 50
21	By amount refunded to E. Stannard, Westbrook, Conn., as overpayment made by him September 24, 1883, on purchase of the U. S. S. Roanoke, paid by check No. 150323 on the Treasurer of the United States, Washington, D. C		05
Dec. 5	By amount deposited in the Treasury of the United States at Washington, D. C., as "Proceeds of sales of old vessels," per duplicate certificate of deposit No. 32164, herewith, voucher 123		122 11
	By bills for tools required in removing old vessels. Paid by Pay Director C. W. Abbot, Boston:		
Nov. 3	Henry Brooks & Co., saws and axes, voucher 128	221 20	
4	B. Callender & Co., saw-handles, voucher 129	3 60	
6	James McCusker, maul-handles, voucher 130	30 00	
	Paid by Pay Director A. H. Gilman, New York:		
9	Geo. H. Creed, saws and saw-files, voucher 135	125 52	
	Paid by Pay Director C. W. Abbot, Boston:		
28	J. A. & W. Bird & Co., borax, voucher 131	2 50	
28	B. Callender & Co., saw-handles, &c., voucher 132	10 26	
29	James Gorman, saw-files, voucher 133	241 00	
Dec. 23	James McCusker, maul-handles, voucher 134	45 00	
	Paid by Paymaster Edwin Putnam, Portsmouth, N. H.:		
Oct. 16	Rider & Cotton, saws, voucher 124	49 44	
16	Rider & Cotton, saw-files, voucher 125	15 00	
Nov. 10	Rider & Cotton, sledge-handles, voucher 126	72 00	
Dec. 9	Rider & Cotton, treenail-augers, voucher 127	23 50	
	Total amount paid for tools during quarter		839 02
	By expense of removing, by breaking up, the U. S. S. Pennsylvania at the Boston navy-yard, for labor employed. Paid by Paymaster J. F. Tarbell, as follows, viz:		
Oct. 15	Pay-roll for first half of October, voucher 136	4,609 65	
31	Pay-roll for second half of October, voucher 137	2,637 24	
Nov. 15	Pay-roll for first half of November, voucher 138	1,430 63	
	Pay-roll for second half of November, voucher 139	166 16	
	Total expense of Pennsylvania during this quarter		8,843 68
	By expense of removing, by breaking up, the U. S. S. Virginia at the Boston navy-yard, for labor employed. Paid by Paymaster John F. Tarbell, U. S. N., as follows:		
Oct. 15	Pay-roll for first half of October, voucher 140	130 25	
31	Pay-roll for second half of October, voucher 141	2,119 83	
Nov. 15	Pay-roll for first half of November, voucher 142	1,944 35	
30	Pay-roll for second half of November, voucher 143	445 84	
Dec. 31	Pay-roll for December, voucher 144	249 14	
	Total expense of Virginia during quarter		4,889 41
	By expense of removing, by breaking up, the U. S. S. Oregon, at the Boston navy-yard, for labor employed. Paid by Paymaster John F. Tarbell, U. S. N., as follows:		
Oct. 15	Pay-roll for first half of October, voucher 145	2,328 32	
31	Pay-roll for second half of October, voucher 146	2,873 44	
Nov. 15	Pay-roll for first half of November, voucher 147	3,434 17	
30	Pay-roll for second half of November, voucher 148	5,368 24	
Dec. 15	Pay-roll for first half of December, voucher 149	499 59	
31	Pay-roll for second half of December, voucher 150	544 56	
	Total expense of Oregon during quarter		15,048 32
	By expense of removing, by breaking up, the U. S. S. Massachusetts at Portsmouth navy-yard, for labor employed. Paid by Paymaster Edwin Putnam, U. S. N., as follows:		
Oct. 31	Pay-roll for the month, voucher 151	10,714 90	
Nov. 15	Pay-roll for the half month, voucher 152	1,303 88	
	Total expense of Massachusetts during quarter		12,018 78

B.—*William E. Chandler, Secretary of the Navy, in account-current, &c.*—**Continued.**

Date.		Amount.	Total.
	Cr.		
	By expense of removing, by breaking up, the U. S. S. Plymouth, at Portsmouth navy-yard, for labor employed. Paid by Paymaster Edwin Putnam, U. S. N., as follows:		
Oct. 31	Pay-roll for month of October, voucher 153	4,611 99	
Nov. 15	Pay-roll for first half November, voucher 154	5,411 54	
30	Pay-roll for second half November, voucher 155	3,174 96	
Dec. 15	Pay-roll for first half December, voucher 156	3,948 43	
31	Pay-roll for second half December, voucher 157	670 93	
	Total expense of Plymouth during quarter		17,817 85
	By expense of removing, by breaking up, the U. S. S. Colossus, at Brooklyn navy-yard, for labor employed. Paid by Pay Director C. H. Eldridge, U. S. N., as follows:		
Oct. 31	Pay-roll for the month, voucher 158	4,339 54	
Nov. 30	Pay-roll for the month, voucher 159	3,775 38	
Dec. 31	Pay-roll for the month, voucher 160	3,334 16	
	Total expense of Colossus during quarter		11,44
	By expense of removing, by breaking up, the U. S. Java, at the Brooklyn navy-yard, for labor employed. Paid by Pay Director C. H. Eldridge, U. S. N., as follows:		
Oct. 31	Pay-roll for the month, voucher 161	2,575 20	
Nov. 30	Pay-roll for the month, voucher 162	2,885 49	
Dec. 31	Pay-roll for the month, voucher 163	5,082 25	
	Total expense of Java during quarter		10,542 94
Dec. 31	By expense of stripping the U. S. S. Colorado, ready for sale at the Brooklyn navy-yard, for labor employed. Paid by Pay Director C. H. Eldredge, per pay-roll, voucher 164		16 96
	By balance on hand, viz:		
	In hands of paymasters as agents	6,106 69	
	On deposit in the Treasury of the United States, Washington	17,633 13	
	Total balance on hand this date		23,
			105,

C.—*William C. Whitney, Secretary of the Navy, in account-current with the United States for "proceeds from sale of old vessels."*

Date.		Amount.	Total.
	Dr.		
	Cash receipts.		
1885.			
Mar. 6	To amount transferred by William E. Chandler, former Secretary of the Navy, by his check on the United States Treasurer, No. 150350		$56,716 38
Mar. 23	To amount received from E. Stannard, of New York, as balance due from him as purchaser of the U. S. S. Colorado, which was sold February 14, 1885, at navy-yard, New York, under the provisions of section 5 of the act of Congress making appropriations to supply deficiencies in the appropriations for the fiscal year ending June 30, 1883, approved March 3, 1883, as follows:		
	Whole amount of sale	$26,700 00	
	Less amount received at time of sale, and accounted for by William E. Chandler, former Secretary	3,000 00	23,700 00
	Balance received by Secretary W. C. Whitney.		
July 14	To amount received from Thomas Butler & Co., as purchasers of U. S. S. Niagara, which was sold May 6, 1885, at navy-yard, Boston, by public auction, by the written authority of the President of the United States, under the provisions of section 5 of the act of Congress making appropriations to supply deficiencies in the appropriations for the fiscal year ending June 30, 1883, approved March 3, 1883, as follows:		
	Whole amount of sale	12,300 00	
	Less commissions of Jerome S. McDonald, auctioneer, as fixed by Secretary of the Navy. Paid by Paymaster J. F. Tarbell, voucher 13.	183 00	
	Balance received by Secretary W. C. Whitney		12,117 00
	Total		92,533 38

C.—*William C. Whitney, Secretary of the Navy, in account-current, &c.*—**Continued.**

Date.		Amount.	Total.
	Cr.		
	Cash expenditures.		
1885.			
ar. 11	By amount deposited in the United States Treasury to the credit of the United States, on account of miscellaneous receipts, proceeds of Government property, sale of old vessels, certificate of deposit No. 32850, voucher 1		51,716 38
13	By amount paid The Item, Philadelphia, for advertising "Proposals for purchase of vessels," under Navy Department's order of January 8, 1885, voucher 2		49 60
19	By amount paid through Paymaster John F. Tarbell, navy-yard, Boston, as labor in breaking up old vessels, as per pay-roll for second half of February, 1885, voucher 3		687 51
28	By amount paid Harper & Brothers for advertising "Proposals for the purchase of vessels" in Harpers' Weekly, under Navy Department's order of March 3, 1884, voucher 4		684 00
y 12	By amount paid through Pay Director C. W. Abbot for tools and materials used in breaking up and removing old vessels at navy-yard, Boston, as follows:		
	H. L. Fearing & Co., rope, voucher 5	275 96	
	Geo. D. Putnam & Co., steel, voucher 6	287 21	
	Geo. D. Putnam & Co., iron, voucher 7	148 23	
	I. Reardon & Sons, tallow, voucher 8	5 65	
	C. A. Whittimore & Co., oil, voucher 9	7 50	
	B. Callender & Co., baskets, voucher 10	9 60	
	B. Callender & Co., nails, voucher 11	4 60	
	B. Callender & Co., augers, voucher 12	75 00	
	Total paid by check on United States Treasurer, No. 150354, in favor of Pay Director C. W. Abbot		813 75
	By bills paid for advertising sale of U. S. S. Niagara, navy-yard, Boston, under Navy Department's order of April 15, 1885, as follows:		
uly 27	The Herald, Boston, voucher 14	11 20	
27	The Philadelphia Demokrat, voucher 15	21 00	
27	The Globe, Boston, voucher 16	17 50	
27	The Graphic, New York, voucher 17	23 20	
16	The News, New York, voucher 18	34 80	
27	The Boston Post, voucher 19	10 80	
27	The Evening Telegram, New York, voucher 20	39 60	
28	The Times, Philadelphia, voucher 21	16 80	
29	The Journal of Commerce, New York, voucher 22	21 60	
30	The World, New York, voucher 23	29 00	
			225 50
	By bills paid for advertising sale of tug Pilgrim, under Navy Department's orders of July 13, 1885, as follows:		
ept. 2	The Baltimore Sun, voucher 24	24 00	
17	The New York Evening Post, voucher 25	29 60	
2	The Philadelphia Abend-Post, voucher 26	18 00	
8	The New York Irish American, voucher 27	37 80	
17	The Philadelphia Times, voucher 28	21 00	
17	The Philadelphia News, voucher 29	24 60	
2	The New York News, voucher 30	43 20	
			198 20
	(The above vessel was offered for sale at public auction, at navy-yard, League Island, Pa., August 12, 1885, by written authority of the President of the United States; but it was not sold, as the maximum bid was not considered a fair price.)		
	By bills paid for advertising sale of tug Rose, under Navy Department's order of July 13, 1885, as follows:		
ept. 17	The Mobile Register, voucher 31	16 00	
17	The Advance-Gazette, Pensacola, Fla., voucher 32	12 50	
			28 50
16	By amount deposited in the United States Treasury to the credit of the United States, on account of "Miscellaneous receipts, proceeds of sale of old vessels," certificate of deposit No. 34294, voucher 33		30,000 00
	Total expenditures		84,403 44
	On deposit in United States Treasury at this date		8,129 94
	Total		92,533 38

No. 3.—DEPOSITS FROM SALES OF GOVERNMENT PROPERTY.

Statement of deposits made on account of sales of Government property, Navy Department, from November 1, 1884, to November 1, 1885.

[Compiled in the Fourth Auditor's Office, by direction of the Secretary of the Treasury.]

Date of deposit.	Place of deposit.	By whom deposited.	Nature of property sold.	Amount covered to miscellaneous receipts.	Amount credited to appropriations.	Total amount deposited.
1884.						
Nov. 4	United States Treasury	W. B. Slack, quartermaster U. S. Marine Corps	Deserters' clothing	$4 60		$4 60
4	New Orleans	Arthur Peterson, passed assistant paymaster	Condemned stores	32 55	$183 25	215 80
7	United States Treasury	H. A. Gill, disbursing agent U. S. Fish Commission	Equipment stores		41 36	41 36
8	do	W. B. Slack, quartermaster U. S. Marine Corps	Old pipe, paint-pots, and marine clothing	4 83		4 83
11	do	H. A. Gill, disbursing agent U. S. Fish Commission	Equipment stores		10 63	10 63
11	New York	G. H. Read, paymaster	Clothing sold to officers		1,000 30	1,000 30
13	First National Bank, Newport, R. I.	T. J. Cowie, assistant paymaster	Provisions issued to officers' messes		5 76	5 76
19	First National Bank, Portsmouth, N. H.	Edwin Putnam, paymaster	Wood from old vessels	141 80		141 80
20	United States Treasury	W. B. Slack, quartermaster U. S. Marine Corps	Deserters' clothing	3 65		3 65
25	New York	G. H. Read, paymaster	Cuttings accumulated at naval clothing factory		280 70	280 70
29	United States Treasury	W. B. Slack, quartermaster U. S. Marine Corps	Trumpet	50		50
29	San Francisco	J. B. Redfield, paymaster	Hulks of Mohican and Modoc	2,202 30		2,202 30
Dec. 1	United States Treasury	W. B. Slack, quartermaster U. S. Marine Corps	Old carpet, furniture, and clothing	44 40		44 40
9	do	do	Old carpet and drugget	3 10		3 10
2	do	J. N. Speel, passed assistant paymaster	Gain on exchange	7 15		7 15
3	New York	C. H. Eldredge, pay director	Old material, shakings, flax clippings, &c.	1,213 51		1,213 51
5	United States Treasury	Secretary of the Navy	Old vessels	122 11		122 11
4	New York	G. H. Read, paymaster	Clothing to officers		934 69	934 69
10	United States Treasury	H. A. Gill, disbursing agent U. S. Fish Commission	Coal		323 73	323 73
11	San Francisco	G. M. Stoney, lieutenant U. S. Navy	Provisions to officers' messes		44 08	44 08
24	United States Treasury	W. B. Slack, quartermaster U. S. Marine Corps	Condemned stores, clothing, &c.	100 80		100 80
1885.						
Jan. 2	First National Bank, Newport, R. I.	T. J. Cowie, assistant paymaster	Empty barrels and provisions	27 77		27 77
5	Boston	J. F. Tarbell, paymaster	Old wood from steamers Virginia, Oregon, and Pennsylvania.	1,145 15		1,14[illegible]
8	United States Treasury	H. A. Gill, disbursing agent U. S. Fish Commission	Coal		103 82	[illegible]
5	New York	G. H. Read, paymaster	Clothing to officers		1,185 08	1,[illegible]
10	Philadelphia	J. Foster, paymaster	Rent of wharf	160 00		[illegible]
12	United States Treasury	W. B. Slack, quartermaster U. S. Marine Corps	Fuel to officers		[illegible]	[illegible]

			do	[illegible]			
		do	do	[illegible]ndemned clothing	10 52		10 52
		do	do	Clothing and trumpets	38 40		38 40
	—	do	H. A. Gill, disbursing agent U. S. Fish Commission	Coal, lumber, copper, &c.		187 27	187 27
	19	do	W. B. Morgan, disbursing clerk U. S. Geological Survey	Labor and material		30 30	30 30
	23	do	H. A. Gill, disbursing agent U. S. Fish Commission	Coal and repairs		1,008 84	1,008 84
	27	do	W. B. Slack, quartermaster U. S. Marine Corps	Bed-sacks, pillow-cases, &c.	5 16		5 16
	27	do	M. Sicard, chief Bureau of Ordnance	Ordnance supplies furnished State of Virginia		164 24	164 24
	31	United States Treasury	W. B. Slack, quartermaster U. S. Marine Corps	Hearth rug	20		20
Feb.	5	do	J. Hoy, pay inspector	Old material and condemned stores	8,366 21	151 41	8,517 62
	4	Exchange National Bank, Norfolk.	R. Parks, pay inspector	Clothing furnished revenue steamer E. A. Stevens.		183 18	183 18
	7	United States Treasury	H. A. Gill, disbursing agent U. S. Fish Commission	Thirty sounding sinkers		21 17	21 17
	9	do	W. B. Slack, quartermaster U. S. Marine Corps	Furniture, clothing, &c.	28 78		28 78
	10	do	H. A. Gill, disbursing agent U. S. Fish Commission	Coal and material		687 89	687 89
	4	New York	G. H. Read, paymaster	Clothing to officers		759 04	759 04
	10	United States Treasury	W. B. Slack, quartermaster U. S. Marine Corps	Fuel to officers		27 75	27 75
	18	First National Bank, Portsmouth, N. H.	E. Putnam, paymaster	Clothing		425 29	425 29
	18	do	do	Small stores		113 13	113 13
	18	do	do	Condemned provisions and stores	1,117 41		1,117 41
	13	Boston	J. F. Tarbell, paymaster	Old material	1,796 13		1,796 13
	18	New York	C. H. Eldredge, pay director	do	24,000 00		24,000 00
	21	Boston	J. F. Tarbell, paymaster	Old furniture	30 54		30 54
	25	Exchange National Bank, Norfolk.	H. C. Machette, paymaster	Old material	4,418 05		4,418 05
	25	Boston	C. S. Norton, captain U. S. Navy	Freight on gold	5 04		5 04
	19	United States Treasury	W. B. Morgan, disbursing clerk U. S. Geological Survey.	Lead and log-line		35 39	35 39
	25	do	H. A. Gill, disbursing agent U. S. Fish Commission	Repairs, material, coal, and wood		95 47	95 47
	26	do	M. Sicard, chief Bureau of Ordnance	Material furnished New Orleans Exposition		447 90	447 90
	21	San Francisco	J. B. Redfield, paymaster	Old material and condemned stores	2,425 24	*784 53	3,209 77
	27	United States Treasury	H. A. Gill, disbursing agent U. S. Fish Commission	Coal and labor		856 41	856 41
Mar.	2	Philadelphia	W. Goldsborough, paymaster	Old material	12,963 15		12,963 15
	5	United States Treasury	J. Hoy, pay inspector	Difference in cost of propeller exchanged for W. P. Wood.	3 68		3 68
	4	New York	C. H. Eldredge, pay inspector	Useless wood	1,501 64		1,501 64
	6	United States Treasury	J. C. Sullivan, passed assistant paymaster	Old material and condemned stores	9,185 54	†2,950 15	12,135 69
Feb.	26	do	H. A. Gill, disbursing agent U. S. Fish Commission	Coal and material		75 54	75 54
Mar.	3	New York	G. H. Read, paymaster	Clothing to officers		452 49	452 49
	12	United States Treasury	Seligman Brothers	Sale of bills of exchange and interest on daily balances.	1,620 54		1,620 54
	17	New York	C. H. Eldredge, pay director	One mule	25 50		25 50
	11	United States Treasury	Secretary of the Navy	Old vessels	51,716 38		51,716 38
	16	New York	G. H. Read, paymaster	Accumulated cuttings		222 98	222 98
	18	United States Treasury	W. B. Slack, quartermaster U. S. Marine Corps	Marine clothing	10 38		10 38
	21	do	E. Putnam, paymaster	Freight on jewels	50 00		50 00
	21	do	A. S. Kenny, paymaster	Premium on American gold	14 32		14 32
	21	do	F. H. Clark, passed assistant paymaster	Condemned oil	45 00		45 00
	21	do	R. Parks, pay inspector	Condemned provisions and premium on gold	79 59		79 59

*$282.51 clothing and small stores; $502.02 ordnance material, proceeds of sales.

†$1,274.82 clothing and small stores; $1,455.33 ordnance material and small arms.

Statement of deposits made on account of sales of Government property, Navy Department, from November 1, 1884, to November 1, 1885—Continued.

Date of deposit.		Place of deposit.	By whom deposited.	Nature of property sold.	Amount covered to miscellaneous receipts.	Amount credited to appropriations.	Total amount deposited.
1885.							
Mar.	21	United States Treasury	L. G. Boggs, passed assistant paymaster	Premium on bills of exchange	97 33		97 33
	24	do	W. B. Slack, quartermaster U. S. Marine Corps	Clothing and accouterments	32 10		32 10
	31	First National Bank, Newport, R. I.	T. J. Cowie, assistant paymaster	Empty barrels	4 64		4 64
Apr.	8	Philadelphia	J. Foster, paymaster	Rent of wharf	200 00		200 00
	7	United States Treasury	J. C. Sullivan, passed assistant paymaster	Condemned stores	236 57	227 10	463 67
	9	New Orleans	A. Peterson, passed assistant paymaster	One horse	22 70		22 70
	22	United States Treasury	J. W. Danenhower, lieutenant U. S. Navy	Stores (Arctic)	43 10		43 10
	25	do	W. B. Slack, quartermaster U. S. Marine Corps	Fuel to officers		1,201 97	1,201 97
	6	do	W. B. Morgan, disbursing clerk U. S. Coast and Geodetic Survey.	Supplies (navigation)		219 41	219 41
	21	do	do	Coal		96 75	96 75
	17	do	H. A. Gill, disbursing agent U. S. Fish Commission	Material		28 01	28 01
	15	do	do	Coal		753 07	753 07
	3	do	do	do		844 00	844 00
	23	do	do	do		66 75	66 75
	7	New York	G. H. Read, paymaster	Clothing to officers		921 83	921 83
	29	United States Treasury	Dorsey Clagett, secretary inaugural committee	Flags lost		257 96	257 96
May	1	New Orleans	A. Peterson, passed assistant paymaster	Miscellaneous stores	921 38	368 39	1,289 77
	5	New York	G. H. Read, paymaster	Clothing to officers		485 78	485 78
	2	United States Treasury	Secretary of the Navy	Boilers of Monocacy	3,738 02		3,738 02
	12	New York	C. H. Eldredge, pay director	Old stores	2,185 41	2,207 50	4,392 91
	7	New Orleans	A. Peterson, passed assistant paymaster	Old vessels	88 80		88 80
	16	United States Treasury	Thomas J. Hobbs, disbursing clerk	Bronze castings		11 58	11 58
	16	do	H. A. Gill, disbursing agent U. S. Fish Commission	Repairs (construction and repair)		112 91	112 91
	16	do	do	Repairs (steam-engineering)		173 90	173 90
	21	First National Bank, Portsmouth, N. H.	E. Putnam, paymaster	Two condemned horses	83 00		83 00
	21	United States Treasury	Chief Bureau of Ordnance	Value of material loaned Soldiers' Home, Boston, unaccounted for.		127 74	127 74
	20	do	G. A. Deering, paymaster	Freight on gold, premium on bills of exchange, brass tubes, old copper, &c.	2,928 41		2,928 41
	20	do	H. T. Wright, paymaster	Condemned provisions	62 44		62 44
	20	do	J. A. Mudd, assistant paymaster	Rent of lots at Yokohama	221 40		221 46
	20	do	F. H. Swan, paymaster	Premium on bills of exchange	121 07		12[illegible]
	20	do	C. S. Williams, assistant paymaster	Old barrels	20 00		[illegible]
	20	do	H. A. Gill, disbursing agent U. S. Fish Commission	Coal		[illegible]	[illegible]

	[illegible]	......do	Secretary of the Navy	Spar furnishe[illegible]ssian corvette Strelok		51 15	51 15
June	1	......do	Seligman Brothers	Gain on bills [illegible]change and interest on daily balances.	16,372 04		16,372 04
	3	New York	C. H. Eldredge, pay director	Condemned stores	398 93	346 30	745 23
	3	United States Treasury	M. Sicard, chief Bureau of Ordnance	Repair of damages to Hotchkiss cannon, amount received from shipping house.		81 84	81 84
	3	New York	G. H. Read, paymaster	Clothing to officers		374 82	374 82
	5	......do	......do	Accumulated cuttings		131 26	131 26
	6	United States Treasury	J. C. Sullivan, passed assistant paymaster	Clothing.		24 85	24 85
	9	......do	W. B. Slack, quartermaster U. S. Marine Corps	Fuel to officers		441 56	441 56
	11	......do	M. Sicard, chief Bureau of Ordnance	Labor and machining a howitzer forging		23 83	23 83
	13	New York	C. H. Eldredge, pay director	One spruce spar		14 00	14 00
	16	United States Treasury	J. H. Chapman, assistant paymaster	Bread-barrels and gain on bills of exchange	107 98		107 98
	15	......do	H. A. Gill, disbursing agent U. S. Fish Commission	Material (steam-engineering)		97 34	97 34
	13	......do	......do	Coal		80 13	80 13
	19	Baltimore	H. C. Machette, paymaster	Condemned stores	211 52	1,415 33	1,626 85
	19	United States Treasury	H. A. Gill, disbursing agent U. S. Fish Commission	Coal		860 91	860 91
	25	Baltimore	F. C. Cosby, pay inspector	Old office furniture	24 56		24 56
	26	United States Treasury	G. A. Lyon, paymaster	Condemned provisions and premium on exchange.	91 31		91 31
	30	Philadelphia	J. Foster, paymaster	Rent of wharf	200 00		200 00
	26	......do	W. Goldsborough, paymaster	Condemned provisions and premium on exchange.	127 38		127 38
July	1	New York	G. H. Read, paymaster	Clothing to officers.		378 87	378 87
	1	Baltimore	F. H. Arms, paymaster	Model of breech-loading rifle made for Naval Academy.		451 14	451 14
	2	First National Bank, Newport, R. I.	T. J. Cowie, assistant paymaster	Provisions to officers' messes		292 40	292 40
	11	United States Treasury	C. F. Goodrich, commander U. S. Navy	Horse and equipment	29 20		29 20
	11	......do	W. W. Woodhull, paymaster	Premium on bills of exchange	45 00		45 00
	21	......do	Seligman Bros	Gain on bills of exchange and interest on daily balances.	3,123 69		3,123 69
	21	......do	E. N. Whitehouse, paymaster	Condemned provisions, and marine clothing	26 83		26 83
	23	New York	C. H. Eldredge, pay director	Old iron	4,302 51		4,302 51
	17	San Francisco	J. B. Redfield, paymaster	Two condemned horses	52 43		52 43
	27	United States Treasury	H. A. Gill, disbursing agent U. S. Fish Commission	Material (steam-engineering, construction and repair, equipment and recruiting).		65 51	65 51
	27	......do	H. C. Machette, paymaster	Shakings	57 25		57 25
	28	......do	H. A. Gill, disbursing agent U. S. Fish Commission	Brass tubes and charcoal		80 90	80 90
	30	......do	......do	Material (construction and repair)		12 12	12 12
	30	......do	......do	Coal and labor		29 88	29 88
	3	......do	H. B. Lowry, quartermaster U. S. Marine Corps	Clothing marines	12 60		12 60
	30	......do	......do	Fuel to officers		377 48	377 48
Aug.	1	......do	......do	Condemned bedsteads, lamp, carpets	4 09		4 09
	4	New York	C. H. Eldredge, pay director	Clothing		2,522 86	2,522 86
	4	......do	......do	Arctic stores	514 64		514 64
	4	United States Treasury	G. A. Bartlett, acting disbursing agent U. S. Coast and Geodetic Survey.	Coal		114 00	114 00
	13	......do	H. A. Gill, disbursing agent U. S. Fish Commission	......do		326 78	326 78
	18	United States Treasury	T. J. Hobbs, disbursing clerk	Bronze castings		10 19	10 19
	19	......do	H. L. Snyder, chief engineer U. S. Navy	Four American ensigns		52 64	52 64
	22	......do	R. Frazer, passed assistant paymaster	Gain on bills of exchange	100 00		100 00
	25	New York	C. H. Eldredge, pay director	Deposits on sales, forfeited	368 00		363 00

Statement of deposits made on account of sales of Government property, Navy Department, from November 1, 1884, to November 1, 1885—Continued.

Date of deposit.		Place of deposit.	By whom deposited.	Nature of property sold.	Amount covered to miscellaneous receipts.	Amount credited to appropriations.	Total amount deposited.
1885.							
Aug.	22	New Orleans	A. Peterson, passed assistant paymaster.	Wharfage of dredge-boat Bailey	197 50		197 50
	21	San Francisco	J. B. Redfield, paymaster.	Condemned stores	176 82	519 97	696 79
	27	United States Treasury	H. B. Lowry, quartermaster U. S. Marine Corps.	Condemned clothing	5 32		5 32
	27	New Orleans	A. Peterson, passed assistant paymaster	Provisions to officers' messes		125 88	125 88
Sept.	8	......do	......do	Repairs to British steamer "Ealing"; coal, oil, and candles.		61 85	61 85
	16	United States Treasury	Secretary of the Navy	Old vessels	30,000 00		30,000 00
	15	New York	G. H. Read, paymaster	Clothing to officers		476 24	476 24
	22	......do	A. J. Clark, pay inspector	Working suits to Naval Academy		205 92	205 92
	26	......do	Brown, Shipley & Co	Interest on daily balances and gain on exchange.	1,039 48		1,039 48
	29	United States Treasury	L. Hunt, assistant paymaster.	Premium on bills of exchange	121 65		121 65
	30	New York.	A. H. Gilman, pay director.	Clothing lost in transit by Old Colony Steamboat Company and Pacific Mail Steamship Company		363 61	363 61
	29	United States Treasury	D. A. Smith, paymaster	Condemned marine clothing	13 15		13 15
	29	......do	W. J. Thomson, paymaster	Sale of "Onward"	1,808 00		1,808 00
	30	First National Bank, Newport, R. I.	T. J. Cowie, assistant paymaster	Provisions to officers' messes		701 07	701 07
Oct.	3	New Orleans	A. Peterson, passed assistant paymaster.	Condemned stores	91 31	1,027 84	1,119 15
	2	United States Treasury	J. A. Mudd, assistant paymaster.	Premium on bills of exchange	21 12		21 12
	8	Boston	A. S. Kenny, pay inspector	Security on boat loaned, forfeited.	60 00		60 00
	12	Philadelphia	J. Foster, paymaster	Rent of wharf	200 00		200 00
	9	New York	G. H. Read, paymaster	Clothing to officers		269 34	269 34
	12	United States Treasury	E. Bellows, paymaster	Condemned flour	1 61		1 61
	12	......do	T. T. Caswell, pay inspector	Condemned marine clothing and premium on exchange.	296 27		296 27
	12	......do	C. W. Slamm, paymaster	Condemned provisions	36 20		36 20
	12	......do	I. G. Hobbs, paymaster.	......do	58 82		58 82
	22	New Orleans	A. Peterson, passed assistant paymaster	Old material	511 36		511 36
	27	United States Treasury	H. B. Lowry, quartermaster U. S. Marine Corps.	Fuel to officers		209 68	209 68
	27	New York	G. H. Read, paymaster.	Accumulated cuttings		121 25	121 25
	20	United States Treasury	Secretary of the Navy	Tug Rose	419 25		419 25
	14	......do	M. Sicard, chief Bureau of Ordnance	Gun-cotton discs		40 81	40 81
	26	......do	......do	Transfer of Hotchkiss machine gun	171 80		171 80
		Total					

No. 4.—MOVEMENTS OF VESSELS.

NORTH ATLANTIC STATION.

The force on this station is still under the command of Acting Rear-Admiral James E. Jouett. The vessels composing it are the Tennessee, Brooklyn, Galena, Swatara, Alliance, and Yantic.

TENNESSEE.

Sailed from New York January 8; arrived at Hampton Roads the 10th, and sailed the 17th; arrived at Key West January 23, and at New Orleans February 4. Telegraphic orders were dispatched to her March 31, "Lose no time in getting to Key West; telegraph arrival; fill up with coal, and wait orders." Later instructions were sent same date to coal at New Orleans, and report when ready. Ordered to proceed to Pensacola to receive detachment of marines on April 2, and to proceed to Colon. Sailed April 3, and arrived at Colon April 10. A serious revolution had occurred on the Isthmus; the steamer Colon, of the Pacific Mail Line, had been seized, and the transit of the Isthmus closed. Previously to the arrival of the Tennessee, with Acting Rear-Admiral Jouett on board, the Galena, already at Colon, had restored the steamer Colon to her owners, but had been unable to prevent the burning of the town and the closing of the transit. The latter was reopened on April 11, by Acting Rear-Admiral Jouett. On 15th April a force of seamen and marines, under the command of Commander B. H. McCalla, reported to Admiral Jouett, to co-operate with the force of the North Atlantic Station in maintaining treaty obligations. The Tennessee remained in Colombian waters until July 15, when she sailed for Hampton Roads. She reached this port July 23, and sailed July 27, reaching New York July 28. Having been docked at the navy-yard, she sailed from New York August 16. On the 18th she reached Bar Harbor, and, sailing thence on the 27th, reached New York August 29. She proceeded to the navy-yard, and was docked on September 7. On October 31, her repairs having been completed, she left the navy-yard, and anchored in the North River.

BROOKLYN.

This ship was put in commission October 15, 1885, at the New York navy-yard.

SWATARA.

Sailed from New York for the West Indies December 16; visited Port of Spain, La Guayra, Carthagena, Porto Cabello, and arrived at Colon January 24. Sailed thence and reached Key West February 14, and New Orleans February 21. Sailed for Guatemala March 5, and returned

to New Orleans March 25. Dispatch sent March 31 to coal at once and report when ready. Sailed for Colon April 2, and arrived there A 9. The Swatara remained in Colombian waters, with the other v of the North Atlantic Station, visiting, as occasion required, the vari ports, until July 14, when she sailed for Key West. She arrived at Key West July 20; sailed thence the 23d, and reached New York the h On August 16 she sailed from New York, and reached New Orlea 28th. Here, in compliance with the request of the United States ır ury, she was loaded with treasure, and on September 11 sailed fı New Orleans in company with the Yantic for Washington. Reacl Washington September 25, the treasure was discharged, and she sailed for New York October 10. She arrived at New York October 12; sailed October 21, and reached Norfolk October 25.

GALENA.

This vessel sailed from New York for Pensacola December 5, 1884, and, touching at Key West, December 12, arrived December 15. She sailed the same day, and reached New Orleans December 16. On Mar 5 she sailed for Colon, and arrived there March 13. Telegraphed Mar 14 to remain at Colon until further orders. On March 30 a party of revolutionists, under the leadership of one Prestan, seized the ste ship Colon, of the Pacific Mail Line. This vessel was restored to rightful owners on the same day by the Galena. On March 31 town of Colon was set fire to and partially destroyed by the revolutionists; the utmost exertions of the force landed from the Galena being able only to save a part of the town and all the property of the Pa Mail Company from destruction. The Galena sailed from Colon on Ju 9; arrived at Kingston, Jamaica, June 13, and at Portsmouth, N. H., June 27. She sailed from Portsmouth August 17, and, having visi Bar Harbor and Eastport, returned to Portsmouth August 27. On November 5 she sailed from Portsmouth; reached Boston the same day; sailed thence November 6, and reached Norfolk November 9.

ALLIANCE.

The Alliance sailed from New York for a cruise in the West Indies on December 11; touching at St. John's, Point-à-Pitre, St. Pierre, and Santiago de Cuba, she reached Colon January 18. She sailed thence on January 23, and, touching at Cienfuegos and Key West, arrived at New Orleans February 17. Sailed for Key West March 22, and arrived March 27. March 31, telegraphed her, "Go direct to Colon with all practicable dispatch." She sailed on March 31 and reached Colon April 8. Sailing thence, June 4, she reached Key West June 7, and New York on June 18. Sailing from New York August 16, she touched at Bar Harbor and Eastport, and reached Norfolk August 31. Here she remained for extensive repairs.

YANTIC.

The Yantic sailed from New York December 1, and reached Christianstaed, Santa Cruz, December 13. Sailing thence on December 19, she touched at St. Thomas, Puerte Plata, Cape Haytien, Mole at St. Nicholas, Colon, Havana, Cardenas, and Key West, and reached New Orleans February 15. On March 16 telegraphed to her to prepare for orders to the coast of Guatemala; and she was ordered on the same

day to proceed to Livingston, and protect the interests of the United States until further orders. On March 23 she reached Key West, and sailed for Livingston, Guatemala, on the 26th. On the 8th of May she was ordered to Colon. Remaining in Colombian waters until August 1, she was there employed in cruising between Livingston, Sabanilla, Carthagena, and Colon. She was then ordered to New Orleans. She reached the latter port on August 17, and, having been loaded with specie, which the United States Treasury wished to transport to Washington, sailed on September 11, in company with the Swatara, for Washington. She reached the latter port on September 25; and, having discharged her treasure, sailed for Norfolk, and reached that port on October 9.

SOUTH ATLANTIC STATION.

The squadron on this station consists of the Lancaster and Nipsic, and is under the command of Rear-Admiral Earl English.

LANCASTER.

The Lancaster, with Rear-Admiral English on board, arrived in the waters of this station on July 1, and Rear-Admiral English at once assumed command of the station; that office having been previously filled by the commanding officer of the Nipsic. On October 15 Admiral English was ordered to send the Lancaster on an extended cruise to Cape Town, Mozambique, Zanzibar, and other ports of the station lying to the eastward of Africa.

NIPSIC.

The Nipsic sailed from Montevideo on January 20, and reached Maldonado on the same day, and returned to Montevideo on the 23d. On March 27 she sailed from Montevideo, and reached Buenos Ayres on the 28th. On April 6 she sailed thence, and reached Colonia the same day. On May 15 she sailed from Colonia, and reached the anchorage in the Rio de la Plata the same day, and, sailing thence on the 27th, reached Montevideo the same day. On June 30 she sailed from Montevideo for Rio de Janerio, where she still remains.

EUROPEAN STATION.

The squadron on this station is at present under the command of Rear-Admiral Franklin, and consists of the Franklin, Quinnebaug, and Kearsarge.

LANCASTER.

The Lancaster, having been ordered to the South Atlantic Station, quitted the waters of the European Station on May 8. Previously to that time her movements were as follows: On December 5 she was ordered to visit the Congo River and vicinity in February. She sailed from Tangier November 9, and arrived at Gibraltar on the same day. Sailed from Gibraltar November 14, and arrived at Port Mahon the 19th; sailed the 26th, and arrived at Villerfanche the 28th. On the

9th February she sailed from Villefranche, and reached Gibraltar the 14th. Sailed thence February 19; and, having touched at Tangier, Senegal, and Libreville (Gaboon), she reached French Point, Congo, on April 28.

PENSACOLA.

The Pensacola was put in commission at Norfolk on April 4, 1885. She sailed from Hampton Roads on May 16; and, having touched at Funchal on June 10, reached Gibraltar June 14. Here Rear-Admiral Franklin, who went out in the Pensacola, assumed command of the European Station. The Pensacola, in company with the Kearsarge, made an extended cruise to the northward during the summer; leaving Gibraltar on July 2, they arrived at Cherbourg July 11, at Copenhagen July 26, at Stockholm August 4, and at Southampton August 26.

KEARSARGE.

In December of 1884, this ship was cruising on the west coast of Africa. She visited Porto Praya, Monrovia, Grand Bassa, Cape Palmas, Cape Coast Castle, and arrived at the Congo River on December 17. On January 8, arrived at Porto Grande. On May 20 she arrived at Saint Vincent, sailed thence on May 22, and reached Funchal May 29. Sailing from Funchal June 8, she reached Tangier June 12, and Gibraltar June 14. From the latter point she made the cruise to the northward already narrated, in company with the Pensacola.

QUINNEBAUG.

This vessel sailed from Villefranche February 16, and reached Smyrna February 24. Sailed thence March 7, and arrived at Constantinople March 9. From this port she visited Smyrna, Beirut, Acre, Haifa, Beirut, Jaffa, Port Said, and Alexandria—reaching the latter port May 17. She sailed from Alexandria June 25, and visited Haifa, Beirut, Smyrna, Chanak, and reached Constantinople on July 22. She sailed from the latter port on August 25, and visited Prinkipio, Buyukdire, Constantinople, Aggria Bay, Smyrna, and Kastio, Chios—reaching the latter port on September 28.

PACIFIC STATION.

The squadron on this station is under the command of Rear-Admiral McCauley, this officer having relieved Rear-Admiral Upshur at San Francisco on May 28, 1885. The squadron at present consists of the Hartford, Shenandoah, Mohican, Iroquois, Adams, Pinta, and Monongahela. The Lackawanna and Wachusett have been detached from the squadron during the year and put out of commission, and the Mohican and Adams have joined it.

HARTFORD.

In obedience to orders from the Department to proceed to S[illegible] cisco, the Hartford sailed from Valparaiso March 18, and reac[illegible]d [illegible] olulu April 20; sailed thence on May 11, and reached San F[illegible] May 27. She sailed from the latter port September 1; and, [illegible] touched at Acapulco September 17, reached Panama October 3.

LACKAWANNA.

On January 2 the Lackawanna sailed from Panama with a party, under the direction of Civil Engineer Menocal, to survey the Nicaragua route for a ship-canal. She arrived at Corinto with this party on January 7. On February 1 she sailed thence and arrived at San José de Guatemala February 4. Sailed next day and reached Acapulco February 10. Sailed February 20 and reached San Francisco March 12. Was put out of commission at the Mare Island navy-yard on April 7.

SHENANDOAH.

Was at Iquiqui on January 6, and proceeded thence on a cruise southward as far as Valparaiso. Telegraphic orders sent March 14 to proceed to Panama and wait orders. The order was received the same day, and she sailed at once, reaching Callao March 29 and Panama April 6. Here she co-operated with the vessels of the North Atlantic fleet in keeping open the transit of the Isthmus of Panama in the manner al- ry narrated. On May 22 she was ordered to proceed to Callao. sailed on the 24th and reached Callao June 2. Owing to the dis- rbed condition of political affairs in Peru, she has remained at the latter port.

MOHICAN.

The Mohican was put in commission for her first cruise at Mare Island on May 25, 1885. She sailed from San Francisco June 27, and reached Panama August 18, having touched at Pichilinque, Acapulco, and Corinto on her way down.

WACHUSETT.

The Wachusett sailed from Callao, in obedience to orders from the Department to proceed to Mare Island, on January 19, 1885, and arrived at Payta February 21. On March 14 she was ordered by telegraph to proceed to La Union, report arrival, and wait orders. She arrived at Panama on 19th March and was ordered on that day to fill up with coal and wait orders. On March 27 she was cabled to proceed to La Union. She arrived at La Libertad April 6, and returned to Panama on May 11, where she was ordered to remain. On July 25 she sailed from Panama, and, having touched at Acapulco on August 5, reached San Francisco August 22. On September 9 she was put out of commission at the Mare Island navy-yard.

IROQUOIS.

In December of 1884 this vessel was occupied in cruising in Australian waters. On January 15 she sailed from Auckland and arrived at Panama on April 26. On June 18 she was ordered to Guayaquil, sailing the next day. She sailed from Guayaquil for Payta on June 29, and arrived July 1. This vessel has also remained in Peruvian waters because the disturbed condition of politics in that country.

ADAMS.

The Adams was put in commission at the Mare Island navy-yard on November 2.

PINTA.

The Pinta has been occupied throughout the year in cruising in Alaskan waters.

MONONGAHELA.

This vessel, the store-ship of the station, has remained throughout the year at Coquimbo, Chili.

ASIATIC STATION.

The Asiatic station has been throughout the year under the command of Acting Rear-Admiral J. L. Davis. The squadron consists at present of the Trenton, Omaha, Marion, Ossipee, Alert, and Palos. The Juniata and Enterprise have been detached and ordered to proceed home during the year, and the Omaha and Marion have joined the squadron.

TRENTON.

The Trenton sailed from Woosung for Corea December 13, 1884; and, sailing thence, reached Nagasaki December 27. On January 13 she sailed from Nagasaki, and reached Woosung on the 21st; and, sailing thence on February 5 reached Hong-Kong February 9. She sailed from Hong-Kong April 2; and touching at Amoy on April 4, arrived at Nagasaki April 14. She sailed thence on April 26, and relieved the Ossipee in Corean waters on May 3. She sailed from Chemulpo, Corea, on June 17, having been relieved by the Alert, and arrived at Nagasaki June 22. On August 27 she went to sea from Nagasaki in company with the Ossipee and Marion for a short drill in steam tactics, and returned to Nagasaki the 30th. On August 31 the Trenton sailed from Nagasaki, arrived at Hiogo September 3, and at Yokohoma September 7. On September 14 she sailed for Tien-Tsin with Mr. Denby, United States minister to China, on board.

OMAHA.

The Omaha was put in commission at the Portsmouth navy-yard on April 16, 1885. She sailed thence on May 18 and reached Newport May 20, having touched at Provincetown on the way down. She proceeded to New York on May 22, and sailed thence for Gibraltar August 12. She reached Gibraltar September 1, sailed the next day, and arrived at Naples September 8. She sailed from Naples October 6, and arrived at Aden October 27.

JUNIATA.

Sailed from Nagasaki for Shanghai and Foochow December 4, arriving the 12th. Sailed from Pagoda anchorage, Foochow, April 7, and arrived at Sharp's Peak April 9. Sailed thence on the 10th and arrived at Shanghai April 14. Sailing thence for Nagasaki on May 20 she reached the latter port May 25, and sailing from that port July 1 she reached Shanghai July 3. She sailed from Shanghai July 5 and arrived at Sharp's Peak the 9th, and, sailing thence the next day, reached Hong-Kong July 13. On July 16 she sailed for home in obedience to orders received from the Department. She reached Singapore July 27, sailed thence July 30, arrived at Zanzibar August 23, sailed thence for Johanna Island August 28, and arrived at King William's Town October 16.

ENTERPRISE.

Sailing from Shanghai January 2, the Enterprise reached Chefoo January 4. Sailing thence she reached Amoy April 2, sailed April 5, and arrived at Sharp's Peak, mouth of the Min River, the next day. Sailing thence, she arrived at Pagoda anchorage April 28. She left the Pagoda anchorage July 2, and dropped down to Sharp's Peak, and sailed thence July 20, and arrived at Hong-Kong July 24, having touched at Amoy for coal. Sailed from Hong-Kong for home, in obedience to orders from the Department, July 28. She arived at Sourabaya, Java, August 10; at Melbourne, Australia, September 17, and at Wellington, New Zealand, October 26.

MARION.

The Marion was put in commission at the Portsmouth navy yard on January 15, 1885. She sailed for Hampton Roads on February 25, and arrived on the 28th. On March 7 she sailed for Gibraltar, and arrived March 30. She touched at Port Said May 5, at Suakin May 21, at Aden May 27, at Colombo June 16, and at Singapore July 5. She arrived at Hong-Kong July 21; and sailing for Nagasaki July 29, arrived there on August 6. On August 27 she went to sea with the Trenton and Ossipee for a short drill in steam tactics. After this drill was over the Marion proceeded to Chemulpo, Corea, to relieve the Alert. She arrived there on September 1.

OSSIPEE.

The Ossipee sailed from Corea for Nagasaki on January 19, and arrived on the 22d. She returned to Corea on the 24th, arriving on the Sailing thence she reached Nagasaki May 12, and, sailing June 6, reached Shanghai June 14. She sailed from Shanghai August 8, and reached Nagasaki August 10. On August 27 she went to sea for a drill in steam tactics, and after this was over started for Yokohama, but, owing to the appearance of cholera on board, put into Hiogo.

ALERT.

The Alert remained at Canton until May 16, when she sailed for Nagasaki. She arrived at Nagasaki May 24, and sailed thence June 9, arriving at Chemulpo, Corea, June 15.

PALOS.

The Palos remained at New Chwang until April 21, when she sailed for Shanghai, arriving April 25. Sailing thence she reached Canton y 11. She sailed from Canton July 10, and arrived at Hong-Kong the same day; thence she proceeded, on July 15, to Sharp's Peak, reaching there on the 17th. From Sharp's Peak she proceeded to Foochow on July 20.

SPECIAL SERVICE.

POWHATAN.

The Powhatan sailed from the Norfolk navy-yard on a cruise on Jan- y 10. Touching at Cape Haytien, Nicola Mole, Port au Prince, Santo iingo, Port Royal, and Kingston, she arrived at Colon March 7. n March 25 she went to Carthagena. Sailing thence she arrived at

Key West May 25 and at New York June 13. On June 26 she went to the navy-yard, and left it October 11. She sailed from New York Hampton Roads October 14, and arrived on the 15th. On October 2 she sailed from Hampton Roads for Aspinwall.

RANGER.

The Ranger remained on the coast of Mexico and Central America making surveys under the direction of the Navy Department until July 13, when she returned to San Francisco. On July 27 she went to Mare Island navy-yard.

DESPATCH.

On April 2 the Despatch was ordered to Norfolk, and on the 3d New York. She arrived in New York April 5. On May 6 she went sea and proceeded to blow up a wreck off Cape Charles. She returned to New York on May 18, and, on June 11, accompanied the Dolphin her trial trip. On July 15 she was placed temporarily at the c of the Board of Fortifications. After this service was over she returned to the navy-yard, and is now being prepared to accompany North Atlantic squadron in their projected drill in Tampa Bay.

MICHIGAN.

The Michigan is cruising on the lakes.

APPRENTICE TRAINING SQUADRON.

PORTSMOUTH.

The Portsmouth left Norfolk on April 13, and arrived at Newport on the 26th. On May 11, this ship as senior officer, with the Jamestown and Saratoga in company, sailed from Newport; and, being separated in a gale in the Gulf Stream in the night of May 13, they proceeded separately to Fayal; the Portsmouth reaching there May 28, the Jamestown having arrived on the 26th, and the Saratoga a few hours before the Portsmouth. The squadron sailed from Fayal in company June 1, and reached Lisbon June 7; sailed thence July 1 and reached Funchal July 8; sailed thence July 25 and reached Fort Point Bay, Long Island, August 31. The Portsmouth arrived at Newport September 3, and sailed thence for Norfolk October 6. She arrived at Fort Monroe October 9, and went to the navy-yard the same day.

SARATOGA.

The Saratoga sailed from Norfolk April 13, and arrived at Newport the 26th. She sailed from Newport in company with the Portsmouth and Jamestown, on May 11, and made the cruise already narrated. On September 3 she arrived at Newport, and sailed for Norfolk October 6, arriving October 9.

JAMESTOWN.

The Jamestown sailed from Hampton Roads April 13, and reached Newport April 26. She sailed from Newport in company with the Portsmouth and Saratoga on May 11, and made the cruise already narrated. She arrived at Newport September 3; sailed thence October 6, and reached Norfolk October 9.

No. 5.—NAVAL ACADEMY.

REPORT OF THE BOARD OF VISITORS.

UNITED STATES NAVAL ACADEMY,
Annapolis, Md., June 6, 1885.

SIR: The Board of Visitors to the U. S. Naval Academy have the honor to submit the following report:

The Board was made up of the following gentlemen: Lieut. Col. Orlando M. Poe, U. S. A.; Hon. John R. Thomas, House of Representatives; Rear-Admiral C. R. P. Rodgers, U. S. N. (not present); Hon. Daniel W. Voorhees, U. S. Senate (not present); Hon. John C. Spooner, U. S. Senate (not present); Hon. Benjamin Le Fevre, House of Representatives; Hon. John G. Ballentine. House of Representatives; Prof. William G. Sumner, New Haven, Conn.; Mr. John N. A. Griswold, New York, N. Y.; Mr. William Reed, Baltimore, Md.; Hon. James S. Grinnell, Greenfield, Mass.; Hon. A. M. Craig, Galesburg, Ill.

The Board was organized on June 1 as follows:

Lieut. Col. O. M. Poe, president.

Hon. John R. Thomas, vice-president.

STANDING COMMITTEES.

(1) *Conditions of Admission and Dismissal at the Academy:* Judge A. M. Craig, Hon. John R. Thomas, Hon. Benjamin Le Fevre, Mr. William Reed, Senator John C. Spooner.

(2) *Subjects of Study and Standard of Scholarship:* Prof. William G. Sumner, Hon. John G. Ballentine, Mr. J. N. A. Griswold, Hon. James S. Grinnell.

(3) *Grounds, Buildings, and Sanitary Condition:* Hon. John G. Ballentine, Senator D. W. Voorhees, Hon. John R. Thomas, Hon. James S. Grinnell, Col. O. M. Poe.

(4) *Seamanship, Ordnance, and Navigation:* Mr. J. N. A. Griswold, Mr. William Reed, Hon. John G. Ballentine.

(5) *Discipline, Drill, Practical Exercises, Administration, and Police:* Hon. John R. Thomas, Judge A. M. Craig, Hon. John G. Ballentine.

(6) *Steam, Mathematics, Physics, and Mechanics:* Mr. William Reed, Senator John C. Spooner, Hon. James S. Grinnell.

(7) *English Studies, Modern Languages, and Drawing:* Senator D. W. Voorhees, Prof. William G. Sumner, Mr. J. N. A. Griswold.

(8) *Finance and Library:* Hon. Benjamin Le Fevre, Judge A. M. Craig.

(9) *Final Report and Selection of Orator to Address the Cadets on Friday, June* 5: Senator John C. Spooner, Prof. Willlam G. Sumner, Senator D. W. Voorhees.

The recommendations of these committees are incorporated under corresponding heads of this report.

I.—CONDITIONS OF ADMISSION AND DISMISSAL.

Under the act of Congress one naval cadet is allowed in the Acad for every Member or Delegate of the House of Representatives, one the District of Columbia, and ten at large. (Rev. Stat., sec. 1513, an act of Congress approved June 17, 1878.)

There are at present 325 Members and 8 Delegates in the Ho Representatives. Allowing one cadet in the Academy for each ber, one for each Delegate, one for the District of Columbia, and ten large, makes the number of cadets allowed at the Academy 344, sh each district be represented as contemplated by the law.

Section 1514, Revised Statutes, provides that the Secretary of Navy shall, as soon after the 5th of March in each year as po ne, notify, in writing, each Member and Delegate of the House of Re sentatives of any vacancy that may exist in his district.

The nomination of a candidate to fill said vacancy shall be made u the recommendation of the Member or Delegate, if such recommenda tion is made by the 1st day of July of that year; but if it is not by that time, the Secretary of the Navy shall fill the vacancy.

The candidate allowed for the District of Columbia, and all the candidates appointed at large, shall be selected by the President.

Under the statute, candidates nominated before the 15th of May, in time to enable them to reach the Academy, are required to present themselves to the Superintendent on that date for examination for admission; but all who may be appointed after that date are required to appear for examination in the month of September.

The effect of the statute as it now stands is that a part of the class each year is admitted in May and a part in September. Upon investigation, the Board find that the practical operation of this practice under the statute is detrimental to the true interests of the cadets, and think that a change of the law in this regard is to be desired.

A mere suggestion would seem to be enough to show the injurious effects of the present system. It will be remembered that a cruise at sea is provided for the cadets each summer, beginning early in June and continued until September 1. Those who are admitted in May participate in this cruise, become familiar with the sea, and secure valuable practical instruction in regard to the management of a ship, and various other matters relating to the course of study, which gives them superior advantages in the study of the books, on their return to the Academy, over those who do not enter until September. Thus, a part of the class begin the course of instruction in the Academy with several months' valuable instruction in advance of the rest of the class, which places those who may enter in September at a great disadvantage in pursuing their studies, which they may never overcome. There are other reasons why this system should not be continued which will readily occur to any person who may give the subject consideration; but it will not be necessary to state them. The Board are fully satisfied that a change should be made, and to meet the difficulty they would suggest that a candidate for admission to the Naval Academy should be appointed at least one year before a vacancy occurs, as is done in the appointment of cadets to the Military Academy, under section 1317, Revised Statutes. And at the time a candidate is appointed the Board would also recommend that an alternate should be named, and that each should be notified and required to appear for examination in May next preceding the vacancy in June. In this way the entire class may be made up on or before the 1st day of June in each y r, start together,

ıd all secure the benefit of the summer cruise at sea, and stand upon] ırfect equality at the beginning of the course. If the candidate was ›inted, as suggested, one year in advance of admission, he might ·e ample time to prepare for examination, would doubtless be much : prepared, and would not be likely to fail on examination, as often urs when he has but a short notice of his appointment, as is the case the present system.

ın regard to the dismissal of cadets from the Academy, we find, upon investigation, in some cases when a cadet has been dismissed for cause, or allowed to resign to avoid dismissal, the same cadet has again been appointed by the Member of Congress in the district where he resides, and in this manner again returned to the Academy.

It is apparent that no school can be successfully managed unless those in control of the institution have the authority to enforce all rules and regulations necessary for the management of the institution; and it is also apparent that the power of suspension or dismissal is among those rules which may or ought to be enforced. But when the power has been properly exercised, if the candidate may be returned the authority to discipline is gone, and practically those in charge are powerless to exercise a salutary rule or regulation which is absolutely necessary in order to manage any school. We are of opinion that here is a wrong which ought to be corrected by proper legislation. In our judgment, the law ought to be so amended as to provide in all cases, where a cadet has been dismissed for cause, or allowed to resign to avoid a dismissal on account of bad conduct, that he should not be eligible thereafter to admission to the Academy.

There is perhaps another matter upon which it seems proper that something should be said. The cadets in the Military Academy at West Point are, by an act of Congress, designated as a part of the Army; but this Board are aware of no statute which directly provides that cadets in the Naval Academy are a part of the Navy. No reason is perceived why, under the law, the cadets at the Naval Academy should not occupy the same position to the Navy that the cadets at West Point do to the Army. One is a school provided by the Government for the education of cadets for the Army, while the other is an institution established by the Government for the education of the cadets for the Navy; and as to powers relating to the discipline of cadets, they should be both placed upon the same ground. The cadets at West Point, under the acts of Congress being a part of the Army, are subject to courts-martial, and the Board are of the opinion that if a similar act was passed declaring the naval cadets to be a part of the Navy, all rules and regulations established for the proper government and management of the Naval Academy might be much better enforced, and thus the Academy might be improved in its usefulness.

II.—Subjects of Study and Standard of Scholarship.

If it is the desire of the Department to secure a thorough and satisfactory inspection of the course of study in the Academy, it would be necessary that the Board charged with that duty should visit the Academy at a time when it is carrying on its regular routine work, and should attend the section-room exercises. Under the actual circumstances, the ›ard have had recourse to the following means of informing themves: They have examined with care the examination questions, which 'e found to be searching and sufficiently numerous and severe knowledge of the cadets. They have also read a number of

the papers written by the cadets in each department, and have satisfied themselves that the standard of marking is high and severe. They have also selected the papers to be read from those which received the highest marks and those which received the lowest, in order to obtain a fair judgment of the attainments of the whole class.

The cadets at this institution need to acquire a great number and variety of practical powers, and to become acquainted with a number of arts, at least to such a degree as to be able to give intelligent directions about them or to know when efficient work is done in them. Instruction and practice in these arts necessarily occupy a great deal of time, and must be taken into account in estimating the work done in the course of study. The Board have observed with great interest and pleasure that the cadets acquire high skill and training, which makes them very efficient men for any service which the country may require of them in their profession. With these arts and the literary acquirements to which the examinations bear testimony, the time must be very fully occupied. If a cadet on entering is only able to pass the examination prescribed for entrance, it does not seem possible that he can advance at the rate which the course assumes and demands. The entrance examination, as its conditions stand on the books, is far below that of the ordinary civil colleges and technical scho[illegible] This fact is supposed to favor a certain class of applicants; [illegible] it is believed that any such opinion is founded in error, and no real kindness is done, probably rather the contrary. The [illegible] therefore believe that the course of study is as full and as vari[illegible] as it is possible to make it within a four-year limit. It is as stric[illegible] and effective as that of the best civil institutions with which the Academy would properly be compared. It could not probably be carried out in its present scope if it were not that the number of students to an instructor is, on an average, only one-fourth or one-fifth of the number in the largest colleges. The Board are also satisfied that the marks are carefully determined by a high standard, and that every precaution is taken to prevent favoritism. The only suggestion which the Board would make for consideration is whether it would not be judicious to provide for graduate courses after the sixth year. A scheme or pl[illegible] for such courses might be invited from the Academic Board.

III.—Grounds, Buildings, and Sanitary Condition.

The Board have carefully examined all the buildings devoted to public purposes at the Naval Academy, and while commending the good care taken by the authorities in the preservation of certain of these buildings, yet cannot forbear expressing their opinion that money is wasted which is bestowed on the preservation of the buildings on Stribling Row, known as the Cadet Old Quarters and Old Recitation Hall.

The Old Quarters from building one to nine Stribling Row are in very bad condition, the foundations have settled, the walls are cracked, the ceilings are falling, the wood-work decayed, and the brick-work crumbling.

The Old Recitation Hall is in a very unsafe and critical conditi[illegible]; walls are badly cracked from foundation to roof, and in some plac[illegible] bulged; ceilings are cracked and window-frames settled and out [illegible] plumb.

The paymaster's store-house is very unsafe and decayed in every particular; ceilings are falling, walls settled and cracked, wood-work rott

r-rot), especially lower-floor joist, and in places the roof leaks like a e.

quarters occupied by the cadets, known as the Upper or New ters, are not large enough to accommodate all the cadets, and are nearly a quarter of a mile from the Old Quarters, which makes it very inconvenient for the cadets and injurious to discipline.

The Board recommend that new quarters be erected on the ground occupied by the Old Quarters (a group of three buildings, one with three stories and two with four stories each), and that a mess-hall and kit n be erected in the rear of and separate from those proposed new rters, as it has been found that the odors arising from the kitchen in basement of the present new quarters are not conducive to the health comfort of the cadets occupying those quarters.

Board recommend further that as many of the officers attached nstructors, &c., to the cadets are obliged to rent quarters in Annap- owing to the present insufficiency of quarters for their use in the emy, the present new quarters be remodeled and adapted for use as additional quarters for officers, professors, and others.

The Board further recommend that the new quarters for the use of Superintendent be at once finished for occupancy, as each year's y in this matter adds to the cost to the Government.

grounds of the Academy are kept in a scrupulously neat and orderly ition, and reflect much credit on the officer in charge of same. This d appearance must benefit the mind and senses of the students, and is y way calculated to do them good. In striking contrast with the ng view from the front windows of the new quarters is that seen the rear windows of the same—rickety, tumble-down rookeries, y streets, and general unsightliness on the one hand, and a garden lelight on the other. The lands occupied by these rookeries, amount- to less than three acres, lie between the present western limits of the Academy and the Government farm, and could no doubt be purchased at a low figure. Sound economy and a desire for the welfare of the Academy demand that this land be purchased and added to the Academy grounds.

Many improvements have been made to the Government farm adjoining the Academy; a sea-wall (and drive) has been nearly completed along the entire shore front thereof, the lands graded and adorned with trees, shrubberies, &c., and terraces made about the portion of the farm known as the Government Cemetery.

The sanitary condition of the Academy is good.

IV.—Seamanship, Ordnance, and Navigation.

The Board have viewed with great satisfaction the exercises in steam-fleet maneuvers and seamanship, as witnessed in the operation of a niature fleet consisting of eight steam-launches, which moved with g precision in different lines of battle, both for attack and defense. The rather obsolete steamer Wyoming was got under way by the ets, including the not altogether pleasant duty of firing up on the b ers and running the machinery; and exercises were had in sending up royal yards, making sail, reefing, and furling, all of which was per- med in a highly satisfactory manner, showing that the practical part of an officer's education had not been neglected. The wind was too it for the Board to see how they would handle a ship under sail.

An exhibition was then had of target-practice with the guns manned rely by cadets. The exercises were entirely satisfactory, showing

great proficiency in handling the guns and very creditable practice at the target, distance being 1,000 to 1,100 yards. The only source of regret, if any, was that the Board did not see a boat drill by landing field-guns from a vessel and attacking a supposed enemy on shore, thus testing efficiently the results of the beautiful drills seen on land.

There is little to be said on the subject of ordnance, except that the Academy ought to be supplied with sample pieces of the latest and most effective guns that have been adopted by our Board of Ordnance. It seems useless to exercise future officers with old, obsolete guns that they may never see in use, and have them practically ignorant of the management and power of modern artillery. The Board would suggest that the Academy be at once furnished with a Hotchkiss 2-inch gun, and also with one of the 6-inch modern steel guns, such as are now at the Experimental Battery at this place.

As regards the seamanship department, a great want is felt in the almost entire absence of models showing how iron vessels are constructed. A full supply of wooden models, showing the construction of wooden vessels in their different stages, are on hand, but they are utterly useless. What is wanted now are working-models, showing in detail the construction of the different types of iron vessels, more especially the heavy iron-clads.

The most remarkable need of the Academy, and, in the opinion of the Board, a very serious one, is for means of instruction about *the construction of modern ships of war of various classes.* The Board urge that steps be taken to supply this need. Too much of the apparatus of instruction in various departments is out of date. The Department of Construction is hardly represented at all.

V.—DISCIPLINE, DRILL, PRACTICAL EXERCISES, &C.

Under the administration of the present Superintendent and his excellent corps of assistants, the discipline of the Academy has reached its highest point of excellence, notwithstanding the fact of the imperfect state of the law governing the Academy. If naval cadets were by law made a part of the Navy, not as officers but as a part subject to the rules and regulations governing the Navy; or if, in other words, they were subject to trial by courts-martial for violations of the rules and regulations of the Academy, or for conduct unbecoming a naval cadet and a gentleman as has been suggested already under I, with reference to dismissal, the moral effect would be salutary, the Superintendent would find it much easier to maintain discipline, and much of the friction caused by lack of power to punish by sentence of court-martial would vanish instantly. We therefore earnestly recommend that the law be amended as above suggested.

For some time the practice of credit marks for good conduct l obtained, and the best possible results have followed. The hope reward more than offsets the natural inclination to violate rules, ıa the result is a high average of good conduct in all the classes.

The inhuman, disgraceful, and unmanly practice of "hazing" se to have well-nigh disappeared from the Academy, and the faithful a impartial execution of the law in that regard by the present Sup n-tendent cannot be too highly commended.

The drills, both infantry and artillery, exhibit the most careful t ing, and the company and battalion maneuvers were creditable alike officers and cadets.

The practical exercises consist in demonstrations of the theo

taught from the books, and serve to strengthen both mind and body and to fasten upon the memory indelibly the facts necessary to be remembered. The present system of practical exercises has developed a brain and brawn in the naval cadets peculiarly fitting them for officers who are to command ships and fight battles.

The administration and police are all that the most critical could ask, and meet the unqualified approval of the Board.

VI.—Steam, Mathematics, Physics, and Mechanics.

The course in steam-engineering now given is in compliance with an act of Congress approved August 5, 1882. Previous to this time there was a distinct corps of cadet engineers whose whole time was devoted to the study of steam-engineering and the subjects connected therewith. Under the act of August 5, 1882, the above distinctive corps was abolished and all naval cadets now take the same course. The Board, while recognizing the wisdom of this change, would respectfully urge the adoption of a post-graduate course to fit more thoroughly for their profession those cadets who, after the completion of their six years' course, become engineers in the service. This post-graduate course is unquestionably necessary, and the plan would entail little or no extra expense on the Government.

The Board find the course of study pursued by the cadets under their able professors and instructors as thorough as the time the cadets can devote to the subject will allow; but the Board cannot too urgently recommend a post-graduate course in the higher branches of applied mathematics. This system would, it appears to us, make the Naval Academy one of the best, if not the best, institution of learning in the world.

The Board find the Department of Physics and Chemistry as complete as theoretical and practical instruction can make it; but they recommend that the present appropriation should continue from year to year, so that this department may be able to give the best instruction in these important and constantly changing sciences.

VII.—English Studies, Modern Languages, and Drawing.

English studies include, as the term is here used, history, grammar, rhetoric, naval and some mercantile law, and international law. The Board have felt a strong interest to see that this department should be fairly developed, for it is the one which might be most easily neglected in an institution of this kind. Examination papers are not careful exercises in composition; but are perhaps as fair tests as more set rhetorical exercises would be. The papers read by the Board include various kinds of rhetorical work, descriptions of machinery, statements of fact and history, argument, statements of law and regulations. The papers read would compare very favorably with those presented by a college class. The drawing exercises which were examined by the Board deserve especial commendation. When it is remembered that the young man who makes the drawing also makes the pattern, works the metal, fits the part to the engine of a steam-launch, works the engine, maneuvers the boat in a fleet of naval steam-vessels, lands a howitzer battery and fights a battle with it, it is plain that few young men enjoy such opportunities for acquiring valuable powers of various kinds as the young men at this institution.

VIII.—FINANCE AND LIBRARY.

The Board carefully examined the methods of purchases and expenditures in the several departments of the Academy coming under the head of Buildings and Grounds, and highly approve the economy and care exercised in this department.

In like manner they examined the mode of purchase for and issue to the cadets of articles of outfit, text-books, clothing, &c., and they commend the business-like manner in which these matters are conducted. The cadets obtain the benefit of wholesale rates on all their purchases.

The accounts of the cadets are kept in a thoroughly plain and comprehensive manner.

The commissariat of the Academy is well conducted, and the articles of food supplied the cadets all that the markets of Baltimore and Annapolis can afford, or that could be required for the health and well being of young gentlemen of their age, habits, and requirements.

The library of the Academy is well supplied with the latest scientific and professional works published, both foreign and domestic. Its condition is excellent, and the Board recommend that Congress be urged to continue, and enlarge if necessary, the usual appropriation made for its support.

The Board at their meeting on June 5, adopted the following resolution, and ordered that it be inserted as part of the report of the Board.

The attention of the Board having been called to the fact that the Board of Visitors in June, 1883, recommended that the act of Aug 5, 1882, be amended, as a similar act in relation to cadets at West Point has been, so as not to include the cadets who had entered the service before the passage of said act:

Resolved, That we concur in this recommendation, and respectfully renew the same for the consideration of Congress.

Hon. John R. Thomas and Hon. Benjamin LeFevre dissented, and asked leave to make a minority report on this subject, which granted.

Very respectfully,

ORLANDO M. POE, *U. S. A.*
JOHN R. THOMAS,
House of Representatives.
BENJAMIN G. LEFEVRE,
House of Representatives.
JOHN G. BALLENTINE,
House of Representatives.
W. G. SUMNER,
New Haven, Ct.
JOHN N. A. GRISWOLD,
New York, N. Y.
WILLIAM REED,
Baltimore, Md.
JAMES S. GRINNELL,
Greenfield, Mass.
A. M. CRAIG,
Galesburg, Ill.

Hon. WILLIAM C. WHITNEY,
Secretary of the Navy.

REPORT OF THE SUPERINTENDENT.

UNITED STATES NAVAL ACADEMY,
Annapolis, Md., October 13, 1885.

ɛ: I have the honor to report that the prescribed course of in-
tion has been carried out during the past year. Thirty-six cadets
leted the four years' course in June last, six passing the required
ination "with distinction" and nineteen "with credit," and were
ed from the Academy to perform two years' service afloat. Twenty
s class entered the Academy as cadet-midshipmen and sixteen as
-engineers.

ɛ usual summer practice cruise was made by the cadets of the first,
, and fourth class, in the sailing practice-ship Constellation.

opy of the report of the commanding officer of the Constellation
losed, marked A.

ɛ cadets of the second class remained at the Academy during the
ıer months, and were daily instructed practically in mechanical
in the shops of the department of steam-engineering; they were
nstructed practically in running and managing steam-launches,
ging boats under oars and under sails, signaling, fleet tactics with
ers, howitzers afloat, target practice with mortars, machine guns,
howitzers, and great guns.

ɛ cadet of the second class was dismissed in September for hazing a
date for admission. Other cadets were engaged in the affair, but suf-
: evidence to bring them to trial by court-martial was not obtained.

essary repairs and improvements have been made to the public
ngs, wharves, and grounds as far as practicable during the year,
ost important of which have been the alteration and enlargement
cadet sick-quarters, to enable the medical officers to isolate cadets
ıay have contagious diseases, and the renewal and rearrangement
't of the system of drainage of the Academy.

:y-eight candidates for admission presented themselves in May
ıd ninety-nine in September. Of this number seventy-four failed
ss the required mental examination and seventeen were rejected
ysical defects.

physical defects of three candidates were waived by the Navy De-
ıt, and one candidate who failed to pass the physical examina-
as admitted to the Academy by order of the Navy Department.
of the candidates who presented themselves September 1, and
to pass the required mental examinations for admission were,
r of the Navy Department, re-examined September 25, in the
s in which they had failed; four of these candidates again
to pass the required mental examinations.

s believed that the short notice given to many candidates is one
ɛ principal causes of the failure of so many to pass the required
ıl examination for admission to the Academy.

ɛ records of the Academy show that during the years 1870 to 1885,
ve, twenty-two hundred and eighteen candidates have presented
elves for examination for admission. Of this number one hun-
ınd eighty were rejected for physical defects, and eight hundred
wenty-six failed to pass the required mental examination. One
and thirty-one of these candidates were between fourteen and
years of age, three hundred and ninety-seven were between
l sixteen years of age, seven hundred and four were between
ınd seventeen years of age, and nine hundred and eighty-six
veen seventeen and eighteen years of age.

Of those between fourteen and fifteen years of age sixty-two per passed the required mental examination, of those between fifteen sixteen years of age sixty per cent. passed, of those between sixteen seventeen years of age sixty per cent. passed, and of those bet seventeen and eighteen years of age only fifty-seven per cent. pa

It is recommended that permits shall be issued to candidates one in advance of the date at which they are to be examined, as is the with candidates for the Military Academy at West Point, and that se 1514 of the Revised Statutes be modified to correspond with section

The recommendation made in the last annual report of the sup tendent, that all candidates shall report for examination for admis on the 15th day of May in each year, is renewed.

For some years past two or more vessels have been used for the mer practice cruise of the cadets, but only one vessel was availabl this purpose in June last, the practice-ship Dale having been found fit for such service by a board of officers ordered by the Departm and no vessel having been furnished to take her place. Fortun the small number of cadets then composing the first and fourth cl enabled all to be carried on board the Constellation.

The number of cadets to go on the next practice cruise renders it n sary that a ship to take the place of the Dale shall be fitted for a prac ship and sent to the Academy by May next. It will be impossibl do justice to the cadets and to give them the required instruction only one practice-ship.

The recommendation made in the last two annual reports of th perintendent, that the act of August 5, 1882, be so modified that th lection of cadets who are to fill vacancies in the lower grades of the and Engineer Corps of the Navy and of the Marine Corps shall be n upon the completion of the four years' course, instead of upon the pletion of the six years' course, is renewed.

Such a change would be in the interests of economy and efficiency, would also be beneficial to the cadets to be discharged. From the erage number of vacancies occurring each year, a cadet who has pleted his four years' course can form a close estimate of his chan getting an appointment in the Navy. Cadets who feel that there i chance of their receiving an appointment take little or no intere their duties on board ship, and only keep themselves up in professi matters sufficiently to pass such an examination at the end of the years as will enable them to be honorably discharged and to rec one year's pay.

The class of cadets that completed the six years' course in June la the first class that completed the four years' course after the passag the act of August 5, 1882. Forty-three cadets reported for examina and twenty of them failed to pass the required written examinat Of those who failed all but one passed upon re-examination. Twe six of this class were honorably discharged and one was allowed t sign. Had these discharges been made at the end of the four years' co instead of at the end of the six-years' course, there would have been sa to the Government during the past two years the salaries of these twe seven cadets, less the salaries of the cadets that would have been pointed to the Academy in their places, amounting to $24,300, there would also have been saved the traveling expenses of these twe seven cadets from foreign stations to Annapolis, six of whom ha travel at Government expense from different parts of the European tion, four from Aspinwall, four from the South Atlantic station, two f the Congo River, three from the Pacific station, and seven from diffe parts of the Asiatic station.

Your attention is respectfully called to the want of legislation, so far as the Naval Academy is concerned, upon the following points:

The oath to be taken by naval cadets when admitted to the Naval Academy.

The time that a naval cadet may be required to serve.

The reappointment of a naval cadet who has been dismissed from the Naval Academy.

The trial of a naval cadet by court-martial, except for the offense of hazing.

It is respectfully recommended that laws similar to those prescribed for the Military Academy at West Point, contained in sections 1320, 1321, 1323, 1325, and 1326 of the Revised Statutes, be enacted for the government of the Naval Academy.

I inclose herewith a statement (marked B) showing under each fic head of appropriation for the Naval Academy the amounts ropriated and expended and the balance unexpended during the year ending June 30, 1885.

A statement (marked C) of offers for supplies and service made during the preceding year.

A statement (marked D) showing the amount expended during the preceding fiscal year in building, repairing, and equipping vessels of the Navy, other than labor performed by enlisted men, and the value of articles received, expended, and on hand for this purpose.

There are no civilians employed at the Naval Academy on clerical duty paid from the appropriation, "pay of the Navy."

I am, sir, very respectfully, your obedient servant,

F. M. RAMSAY,
Captain, U. S. Navy, Superintendent.

CRUISE OF THE PRACTICE-SHIP CONSTELLATION.

UNITED STATES PRACTICE-SHIP CONSTELLATION,
Annapolis, Md., August 27, 1885.

SIR: I have the honor to submit the following report of the practice cruise of 1885.

The Constellation sailed from Annapolis on the 16th June with the following officers: Commander C. L. Huntington, commanding; Lieut. R. R. Ingersoll, executive officer; Lieut. G. W. Tyler, navigator; Lieut. E. B. Barry, watch officer; Lieut. J. W. Danenhower, watch officer; Lieut. H. C. Gearing, watch officer; Ensign J. G. Quinby, watch officer; Ensign C. S. McClain, watch officer; Ensign R. C. Smith, assistant to navigator; surgeon, G. A. Bright; passed assistant surgeon, J. W. Steele; Paymaster J. P. Loomis, commissary; chaplain, A. A. McAlister.

There were on board 123 naval cadets and a crew of 197 petty officers, men, and marines, and others. Six additional seamen were received board at Hampton Roads, where the ship arrived on the 18th June. sailed from Chesapeake Bay June 22, and cruised between latitudes N. and 37° N., and as far east as longitude 72° W., until July 12, and n sailed for Portsmouth, N. H., direct, arriving there on the 17th July. Commodore Johnson and the other officers of the navy-yard offered every facility for viewing the various departments and workshops, and detail of cadets under charge of an officer was sent to visit some point interest every day.

the 31st July sailed from Portsmouth for the cruising ground be- mentioned; cruised until the 13th August, and on that day anchored Lynn Haven Roads.

Sailed for Annapolis August 17, anchoring every night and spending several profitable days at the mouth of the Patuxent River, arriving at the U. S. Naval Academy August 27. About Nantucket Shoals and as far north as Cape Ann thick weather and heavy fogs were encountered; otherwise the weather was very favorable.

The cadets of the first class were divided into two parts, one for duty as junior watch officers and mates of decks, and the other as seamen petty officers. The parts exchanged duties every week. The other cadets had regular stations with the crew, and the eight yards were manned chiefly by them. Cadets of all classes, with very few exceptions, seemed fearless aloft.

The cadets have received the following practical instruction in seamanship:

Getting under way and coming to anchor under various circumstances. Loosing and furling, and making and shortening sail. Reefing and hoisting. Shifting topsails. Shifting fore-topsail, as in chase. Sending down light yards to windward. Sending down and up royal and top-gallant yards and masts. Sending down lower yard and topmast. Carrying out a bower anchor, weight 6,000 pounds, between two boats. Boat sailing. Heaving the lead. Knotting and splicing. Signaling. Tacking, wearing, box-hauling. Making up, setting, and taking in studding sails. Man overboard. Hoisting out and in boats. Placing a collision mat under bottom of the ship. Abandon ship.

Cadets of the first class were all given opportunities for working ship as officer of the deck, and all classes were required to submit seamanship notes every week, as, for instance:

Subjects for note-books for the week ending June 20, 1885.

First class.—Will make a note and submit on Saturday the manner of bringing to a chain; heaving up; catting and fishing an anchor and securing it for sea.

Third class.—All standing rigging; manner of fitting and order in which it goes over mast-heads. Sketch a lower mast-head.

Fourth class.—Parts of the ship: masts, yards, and sails; name the gear of a topsail and describe its use.

In navigation cadets of the third class received instruction as follows:

Day's work, great circle, middle latitude, and mercator's sailing. Adjustment of the sextant. Longitude by time-sights of sun, moon, planets, and stars, and Sumner's lines. Latitude by meridian, altitude of sun, moon, and stars. $\varphi-\varphi'$ method by sun and stars. Versed sine and circum-meridian method. Ship's position by twilight observation of two stars, and by cross-bearings of objects on shore. Compass errors. Time of sunset and high water. Log books.

Target practice with great guns was had every Monday, when practicable, and the cadets were instructed in plotting the fall of the projectiles on a vertical plane by the polar-distortion diagrams furnished by the Bureau of Ordnance.

There were three exercises at general quarters at night.

In target practice the firing was very good, showing the benefit of the progressive instruction received at the Academy.

In addition to their routine ship duties the officers all performed their duties as instructors faithfully and well.

The health of the cadets throughout the cruise was excellent, due in great measure to the very superior mess arrangements of the commissary.

I am, sir, very respectfully, your obedient servant,

C. L. HUNTINGTON,
Commander, U. S. N., Commanding.

Capt. F. M. RAMSAY,
Superintendent United States Naval Academy.

B.—*Statement of the appropriation of the Naval Academy for the fiscal year ending June 30, 1885.*

Headings of appropriation.	Amount appropriated.	Amount expended to June 30, 1885.	Balance unexpended June 30, 1885.	Amount expended since June 30, 1885, for supplies ordered prior to June 30, 1885.	Amount of liabilities for supplies ordered prior to June 30, 1885.
For pay professors and others	$53,559 00	$50,699 79	$2,859 21		
For pay watchmen and others	23,044 00	21,805 17	1,238 83		
For pay mechanics and others	14,583 60	14,040 24	543 36		
For pay of steam-employés	7,669 50	7,200 18	460 32		
For repairs	21,000 00	20,075 48	924 52	$924 52	
For heating and lighting	17,000 00	16,719 55	280 45	280 45	
For library	2,000 00	1,274 47	725 53	725 53	
For stationery, &c	2,000 00	1,994 41	5 59		$5,59
For expenses of the Board of Visitors	1,500 00	1,476 57	23 43		
For chemicals, apparatus, &c	2,500 00	1,829 61	670 39		670 39
Miscellaneous	34,600 00	31,554 21	3,045 79	1,945 79	1,100 00
For stores, steam-engineering	800 00	800 00			
For material, steam-engineering	1,000 00	1,000 00			

C.—*Statement of offers for supplies and service for the Naval Academy, made during the fiscal year ending June 30, 1885.*

[Schedule of offers for supplies for the United States Naval Academy, under advertisement June, 1884.]

Coal:

- For 2,800 tons Cumberland coal:
  - The Consolidation Coal Company, at $2.59 per ton *$7,252 00
  - Ehlen Bros., at $3.04 per ton 8,512 00
  - Black, Sheridan & Wilson, at $2.95 per ton 8,260 00
  - S. M. Hamilton & Co., at $2.75 per ton 7,772 00
  - West Virginia Central and Pittsburgh Railroad Company, at $2.85 per ton 8,134 00
  - Baker, Whitely & Co., at $2.95 per ton 8,260 00
- For 600 tons anthracite coal:
  - J. S. M. Basil, at $3.98 per ton *2,388 00
- For 600 tons Newburg Orrel, or Youghiogheny gas coal:
  - Newburg Orrel Coal Company, at $4.15 per ton *2,490 00
  - S. M. Hamilton & Co., at $4.29 per ton 2,574 00
  - Black, Sheridan & Wilson, at $4.25 per ton 2,550 00

[Under advertisement of September, 1884.]

For granite coping stone:

- W. F. Weller *980 00
- McClenahan & Bro 1,100 00
- J. E. Sudler 3,245 00
- Berry & McFrederick 1,362 00

[Under advertisement of February, 1885.]

Lumber:

- Otto Duker & Co *452 00
- Samuel Burns & Co 482 00
- Jos. Thomas & Son 502 00
- G. F. Sloan & Bro 457 00
- Jos. Turner 514 00

[illegible]:

- [illegible]urg, Hollander & Co *875 97
- [illegible] Claridge & Co 949 97
- [illegible] H. Bixler 892 40
- [illegible] Popplein, jr 892 80

* Accepted.

Paint-brushes:	
J. Bond Carroll & Bro	*$10
W. H. H. Bixler & Co	11
Hirshburg, Hollander & Co	11
Cleaning material:	
Lord & Packham	*8
Loud, Claridge & Co	9
Brick:	
For 10,000 each, arch, paving, and dark red:	
George N. Potee	*31
W. H. Classen	31
Glass:	
Swindell Bros	*
G. & N. Popplein, jr	1
W. H. H. Bixler	2
Hirshburg, Hollander & Co	1
Loud, Claridge & Co	1
Bar-iron and steel:	
C. Winternitz & Son	*5
J. Register & Son	5
Hardware:	
Anderson & Ireland	*12
W. H. H. Bixler	20
Rosendale cement, lime, plasterers' hair, &c.:	
Russell, Giese & Co.	*15
G. M. Hay	15
J. S. M. Basil & Parlett	17
S. M. Hamilton	18
W. W. Clarke & Son	16
Portland cement:	
Russell, Giese & Co	*13
W. H. Classen & Co	13
S. M. Hamilton	14
W. W. Clark & Son	13
Stone coping:	
McClenahan Bros	*27
Myers & Keifer	58
W. F. Weller	29
Light builder's stone:	
McClenahan Bros	*34
Rubble building stone:	
McClenahan Bros	*24
Myers & Keifer	24
Gas, steam, and water pipe, and fitting:	
J. Register & Son	*76
T. C. Basshor & Co	80
Crook, Horner & Co	†66

[Under requisition No. 9, 1884.]

Cocoa mats:	
Lyon, Hall & Co	*$1
John Turnbull	1
Lord & Packham	1

[Under requisition No. 22.]

Heavy wrought-iron pipe and fittings:	
T. C. Basshor & Co	*9
C. Y. Davidson & Co	9
J. Register & Son	9
For fish-trap for water-main, as per drawing and specification:	
Caroline Iron Works	*18
James Bates	25

*Accepted. †Only a partial bid.

[Under requisition No. 25.]

Building gravel:		
Washington White	per bushel	$0 12½
Washington White, per bushel	do	*10
D. J. Sanders	do	12

[Under requisition No. 27.]

Baltimore kitcheners:		
W. H. F. Wilson & Son		*90 00
Hutchinson Bros		90 00
Bartlett, Hayward & Co		100 00

[Under requisition No. 29.]

Ground glass:		
Baker Bros. & Co		45 00
Hirshburg, Hollander & Co		*42 50
George & N. Popplein, jr		52 50

[Under requisition No. 30.]

Dressed lumber:		
Otto Duker & Co		*43 47
Jos. Thomas & Son		48 68

[Under requisition No. 31.]

Sheepskins:		
George Appold & Sons		*2 75
Turned cedar posts:		
Jos. Thomas & Son	each	*1 50
Samuel Burns & Co	do	3 00
Otto Duker & Co	do	2 75
Pew ends for chapel:		
Jos. Thomas & Son		*22 00

[Under requisition No. 32.]

Gas fixtures for chapel:		
C. Y. Davidson & Co		*492 00

[Under requisition No. 34.]

Adjustable drawing-tables (patent):		
The Washburn Machine Shop	each	*8 00

[Under requisition No. 35.]

Bath-tub:		
J. Register & Son		*16 50
T. C. Basshor & Co		17 75
C. Y. Davidson & Co		20 00
Glass for library windows:		
Swindell Bros		*36 59
Baker Bros. & Co		39 50
Hirshburg, Hollander & Co		43 69

[Under requisition No. 36.]

Cements:		
W. Wirt Clarke & Son		*114 00
Russell, Giese & Co		119 10
J. S. M. Basil & Parlett		123 90
Pine wood:		
John Kealy	per cord	*3 40
J. S. M. Basil & Parlett	do	3 50
John B. Flood	do	3 50
J. S. M. Basil	do	3 47
Oats:		
Mahool & Probest	per bushel	*40
H. B. Myers	do	42
J. S. M. Basil & Partett	do	40
John Kealy	do	41¾

* Accepted.

D.—*Statement showing the amount expended during the fiscal year ending June 30, 188 building, repairing, and equipping vessels of the Navy other than labor performed by enl men, and the value of articles received, expended, and on hand for this purpose.*

Expended for wages of mechanics and laborers	$26
Expended in receiving and securing stores and materials for this purpose	
Expended for the purchase of material and stores for this purpose	57
Cost or estimated value of stores on hand under this appropriation June 30, 1884	36,
Cost or estimated value of articles received	14,
Cost or estimated value of articles expended	14,90
Cost or estimated value of articles belonging to this appropriation on hand June 30, 1885	36,53

Estimates of appropriations required for the service of the fiscal year ending June 30, 1 by the United States Naval Academy.

Detailed objects of expenditure, and explanations.	Estimated amount which will be required for each detailed object of expenditure.	Amount appropriated for the current fiscal year, ending June
NAVAL ACADEMY.		
FOR PAY OF PROFESSORS AND OTHERS.		
One professor of mathematics and one of chemistry, at $2,500 each (March 3, 1885)	$5,000 00	
Three professors (assistants) namely: One of physics, one of French and Spanish, and one of English studies, history, and law, at $2,200 each (same act)	6,600 00	
Four assistant professors, namely: Three of French and one of drawing, at $1,800 each (same act)	7,200 00	
One sword-master, at $1,500, and two assistants, at $1,000 each (same act)	3,500 00	
One boxing-master and gymnast, at $1,200 (same act)	1,200 00	
One assistant librarian, at $1,400 (same act)	1,400 00	
One secretary of the Naval Academy, at $1,800 (same act)	1,800 00	
Three clerks to the superintendent, at $1,200, $1,000, and $800 respectively (same act)	3,000 00	
One clerk to commandant of cadets, at $1,200 (same act)	1,200 00	
One clerk to paymaster, at $1,000 (same act)	1,000 00	
One dentist, at $1,600 (same act)	1,600 00	
One baker, at $600 (same act)	600 00	
One mechanic in department of physics and chemistry, at $730 (same act)	730 00	
One cook, at $325.50 (same act)	325 50	
One messenger to superintendent, at $600 (same act)	600 00	
One armorer, at $529.50 (same act)	529 50	
One gunner's mate, at $469.50 (same act)	469 50	
One quarter-gunner, at $409.50 (same act)	409 50	
One cockswain, at $469.50 (same act)	469 50	
One seaman in department of seamanship, $349.50 (March 3, 1885)	349 50	
One attendant in the department of astronomy, and one in the department of physics and chemistry, at $300 each (same act)	600 00	
Six attendants at recitation rooms, library, store, chapel, and offices, at $240 each (same act)	1,440 00	
One band-master, at $528 (same act)	528 00	
Twenty-one first-class musicians, at $348 each (same act)	7,308 00	
Seven second-class musicians, at $300 each (same act)	2,100 00	
For additional pay to second and third clerks to superintendent, at $200 each (submitted)	400 00	
(This recommendation is made that the second and third clerks to the superintendent may receive pay commensurate with their duties.)		
For one assistant in library, $750 (submitted)	750 00	
(The increased size of the library and its annual increase require the daily services of an assistant.)		
For additional pay to mechanic in the department of physics and chemistry, that he may be paid at the rate of $3 per day (submitted)	209 00	
(The man filling this position must be a skilled mechanic and instrument-maker.)		
For one letter-carrier, at $2 per day (submitted)	730 00	
(There is no free delivery in Annapolis. It requires the daily services of one man to obtain, post, and deliver the mail matter of the officers, instructors, cadets, and enlisted men at the Academy. This service has been performed for the past thirty years by a laborer.)		

* Accepted.

Gold-leaf and dryer:		
G. & N. Popplein, jr		*$10 25
Hirshburg, Hollander & Co		12 00

[Under requisition No. 7, 1885.]

Globes for gas-fixtures:		
Cornelius & Co		*30 00
C. Y. Davidson & Co		36 00

[Under requisition No. 11.]

Composition nails:		
Cumberland, Dugan & Co		*38 35
Anderson & Ireland		41 00

[Under requisition No. 25.]

Bath-boilers:		
J. Register & Son		*18 80
Crook, Horner & Co		18 81
Oak lumber:		
Otto Duker & Co		*32 00
Samuel Burns & Co		32 00
Jos. Thomas & Son		36 00

[Under requisition No. 26.]

Tin-plate:		
Keen & Haggerty		*53 99
William Fuller & Co		54 60
E. L. Parker & Co		59 06

[Under requisition No. 34.]

Building gravel:		
S. P. Kelly	per 1,000 bushels	*40 00
G. O. Ward	do	50 00
L. A. Shores	do	60 00
H. Campbell	do	60 00
T. H. Ward	do	77 50
W. White	do	70 00
T. Kelly	do	60 00

[Under requisition No. 35.]

in roofing:		
W. H. F. Wilson & Son		*29 00
J. H. League & Son		31 00

[Under requisition No. 42.]

ling dirt:		
John T. Bishop	per cart-load	*09
A. Meyett	do	20
ng sod:		
John T. Bishop	per cart-load	*20
A. Meyett	do	30

[Under requisition No. 45.]

icks:		
George N. Potee		*1,275 00
H. W. Classen & Co		1,312 50
ork for sick-quarters, as per specifications of architect:		
Otto Duker & Co		*377 80
Jos. Thomas & Son		382 85
er:		
Otto Duker & Co		*890 17
Samuel Burns & Co		914 27
Jos. Thomas & Son		1,137 60
work:		
Gault & Son		*323 63
. B. Hanna		378 75

[Under requisition No. 47.]

for boiler fronts:		
s Bates	per pound	*02
B. . Larrabee & Co	do	02½

*Accepted.

D.—*Statement showing the amount expended during the fiscal year ending June 30, 1885, in building, repairing, and equipping vessels of the Navy other than labor performed by enlisted men, and the value of articles received, expended, and on hand for this purpose.*

Expended for wages of mechanics and laborers	$260 57
Expended in receiving and securing stores and materials for this purpose	8 35
Expended for the purchase of material and stores for this purpose	577 49
Cost or estimated value of stores on hand under this appropriation June 30, 1884	36,625 19
Cost or estimated value of articles received	14,812 65
Cost or estimated value of articles expended	14,900 80
Cost or estimated value of articles belonging to this appropriation on hand June 30, 1885	36,537 04

Estimates of appropriations required for the service of the fiscal year ending June 30, 1887, by the United States Naval Academy.

Detailed objects of expenditure, and explanations.	Estimated amount which will be required for each detailed object of expenditure.	Amount appropriated for the current fiscal year, ending June 30, 1886.
NAVAL ACADEMY.		
FOR PAY OF PROFESSORS AND OTHERS.		
One professor of mathematics and one of chemistry, at $2,500 each (March 3, 1885)	$5,000 00	
Three professors (assistants) namely: One of physics, one of French and Spanish, and one of English studies, history, and law, at $2,200 each (same act)	6,600 00	
Four assistant professors, namely: Three of French and one of drawing, at $1,800 each (same act)	7,200 00	
One sword-master, at $1,500, and two assistants, at $1,000 each (same act)	3,500 00	
One boxing-master and gymnast, at $1,200 (same act)	1,200 00	
One assistant librarian, at $1,400 (same act)	1,400 00	
One secretary of the Naval Academy, at $1,800 (same act)	1,800 00	
Three clerks to the superintendent, at $1,200, $1,000, and $800 respectively (same act)	3,000 00	
One clerk to commandant of cadets, at $1,200 (same act)	1,200 00	
One clerk to paymaster, at $1,000 (same act)	1,000 00	
One dentist, at $1,600 (same act)	1,600 00	
One baker, at $600 (same act)	600 00	
One mechanic in department of physics and chemistry, at $730 (same act)	730 00	
One cook, at $325.50 (same act)	325 50	
One messenger to superintendent, at $600 (same act)	600 00	
One armorer, at $529.50 (same act)	529 50	
One gunner's mate, at $469.50 (same act)	469 50	
One quarter-gunner, at $409.50 (same act)	409 50	
One cockswain, at $469.50 (same act)	469 50	
One seaman in department of seamanship, $349.50 (March 3, 1885)	349 50	
One attendant in the department of astronomy, and one in the department of physics and chemistry, at $300 each (same act)	600 00	
Six attendants at recitation rooms, library, store, chapel, and offices, at $240 each (same act)	1,440 00	
One band-master, at $528 (same act)	528 00	
Twenty-one first-class musicians, at $348 each (same act)	7,308 00	
Seven second-class musicians, at $300 each (same act)	2,100 00	
For additional pay to second and third clerks to superintendent, at $200 each (submitted)	400 00	
(This recommendation is made that the second and third clerks to the superintendent may receive pay commensurate with their duties.)		
For one assistant in library, $750 (submitted)	750 00	
(The increased size of the library and its annual increase require the daily services of an assistant.)		
For additional pay to mechanic in the department of physics and chemistry, that he may be paid at the rate of $3 per day (submitted)	200 00	
(The man filling this position must be a skilled mechanic and instrument-maker.)		
For one letter-carrier, at $2 per day (submitted)	730 00	
(There is no free delivery in Annapolis. It requires the daily services of one man to obtain, post, and deliver the mail matter of the officers, instructors, cadets, and enlisted men at the Academy. This service has been performed for the past thirty years by a laborer.)		

* Accepted.

Estimates of appropriations required for the service of the fiscal year, &c.—**Continued.**

Detailed objects of expenditure, and explanations.	Estimated amount which will be required for each detailed object of expenditure.	Amount appropriated for the current fiscal year, ending June 30, 1886.
FOR PAY OF PROFESSORS AND OTHERS—continued		
For additional pay to six attendants at recitation rooms, library, store, chapel, and offices, at $5 per month each (submitted)	$360 00	
(These men are obliged to clothe, feed, and lodge themselves, and cannot do so on $20 per month.)		
For one messenger to commandant of cadets, at $25 per month (submitted)	300 00	
(A messenger is absolutely necessary to the commandant of cadets to carry orders to the officers, instructors, and cadets.)		
	52,708 00	$53,559 00
FOR PAY OF WATCHMEN, MECHANICS, AND OTHERS.		
For captain of the watch and weigher, at $2.50 per day (March 3, 1885)	912 50	
Four watchmen, at $2 per day each (same act)	2,920 00	
Foreman of the gas and steam-heating works of the Academy, at $5 per day (same act)	1,825 00	
Ten attendants at gas and steam-heating works; one at $3, one at $2.50, and eight at $2 per day each (same act)	7,847 50	
One yeoman, $600 (same act)	600 00	
One foreman of joiners, one foreman of painters, and one foreman of masons, at $3.50 per day each (same act)	3,286 50	
One mason, at $3 per day (same act)	939 00	
Two joiners and one painter, at $2.50 per day each (same act)	2,347 50	
One tinner, one gas-fitter, and one blacksmith, at $2.50 per day each (same act)	2,347 50	
One mechanic at work-shop, at $2.25 per day (same act)	704 25	
One master laborer to keep public grounds in order, at $2.28 cents per day (same act)	832 20	
Fifteen laborers to assist in same, three at $2 per day each, and twelve at $1.50 per day each (same act)	7,510 50	
One laborer to superintend and keep in order upper quarters of naval cadets, at $2 per day (same act)	730 00	
Twenty servants to keep in order and attend to quarters of naval cadets and public buildings, at $20 per month each (same act)	4,800 00	
For four laborers at gas and steam-heating works, at $1.50 per day each (submitted)	2,190 00	
(This increase is recommended to enable the authorities of the Naval Academy to comply with the requirements of section 3738 of the Revised Statutes. At present it is necessary to require eight of the attendants in the gas and steam-heating works of the Academy to work twelve hours per day.)		
For one attendant in the purifying house of the gas-house, at $1.50 per day (submitted)	547 50	
(This position has been filled by an enlisted man for some years, until September, 1885, when the allowance of enlisted men to the ships at the Academy was reduced, and this attendant was discharged.)		
For eight laborers to keep in order public grounds, at $1.25 per day each (submitted)	3,130 00	
(These positions have been filled by enlisted men from 1869 until September, 1885, when the allowance of enlisted men to the ships at the Academy was reduced, and these eight men were discharged by order of the Chief of the Bureau of Equipment and Recruiting. At date of discharge each of these men was receiving $337.50 per annum. The proposed pay will give each man $391.25 per annum, 313 working days.)		
For one laborer to superintend and keep in order lower quarters of naval cadets, at $2 per day (submitted)	730 00	
(This necessary position has been filled by an enlisted master-at-arms from 1874 until September, 1885, when the allowance of enlisted men to the ships at the Academy was reduced, and the master-at-arms was discharged by order of the Chief of the Bureau of Equipment and Recruiting. At date of discharge the master-at-arms was receiving $989.50 per annum.)		
For additional pay to twenty servants to keep in order and attend to quarters of naval cadets and public buildings, at $5 per month each (submitted)	1,200 00	
(These men are obliged to clothe, feed, and lodge themselves, and cannot do so on $20 per month.)		
	45,399 95	37,602 45

Estimates of appropriations required for the service of the fiscal year, &c.—Continu

Detailed objects of expenditure, and explanations.	Estimated amount which will be required for each detailed object of expenditure.	Amount appropriated for the cur-
FOR PAY OF THE EMPLOYÉS IN DEPARTMENT OF STEAM-ENGINEERING.		
One master machinist, one boiler-maker, and one pattern-maker, at $3.50 per day each (March 3, 1885)	$3,286 50	
Two machinists and one blacksmith, at $2.50 per day each (same act)	2,347 50	
Four laborers, at $1.50 per day each (same act)	2,034 00	
For additional pay to one master machinist, that he may be paid at the rate of $4 per day (submitted)	156 50	
(The master machinist in the department of steam-engineering is required to do the duty of foreman of the machine-shop, to assist in the practical instruction of the naval cadets in that department, and to make the necessary repairs to the engines and boilers of the vessels and launches.)		
For one master machinist for eleven days (extra time), at $4 per day (submitted)	44 00	
For one boiler-maker and one pattern-maker for eleven days (extra time), at $3.50 per day each (submitted)	77 00	
For two machinists and one blacksmith for eleven days (extra time), at $2.50 per day each (submitted)	82 50	
For four laborers for eleven days (extra time), at $1.50 per day each (submitted)	66 00	
(During eighty-five days of the year the practical instruction of the naval cadets in steam and machinery makes it necessary for the employés of the Department of Steam-Engineering to work two hours more per day than the period prescribed by section 3738, Revised Statutes. This extra time is equal to eleven working days.)		
For one molder, at $2.50 per day (submitted)	782 50	
(The services of a molder are necessary; one has been allowed, except during the past three years.)		
	8,876 50	$7
For necessary repairs of public buildings, pavements, wharves, and walls inclosing the grounds of the Naval Academy, and for improvements, repairs, and furniture and fixtures (same act)	21,000 00	21
For fuel for heating and lighting the Academy and school-ships (same act)	17,000 00	17
FOR CONTINGENT EXPENSES—NAVAL ACADEMY.		
For purchase of books for the library (March 3, 1885)	2,000 00	2
For stationery, blank-books, models, maps, and for text-books for use of instructors (same act)	2,000 00	2
For expenses of the Board of Visitors to the Naval Academy (same act)	1,500 00	
For additional expenses of the Board of Visitors to the Naval Academy (submitted)	1,000 00	
(The amount appropriated for the expenses of the Board of Visitors for the fiscal years ending June 30, 1884 and 1885, was sufficient for the maintenance of the Board while at the Academy, but was not sufficient to meet that expense and the mileage of the Visitors from and to their homes. The mileage of the ten members of the Board of Visitors present in 1883 was $1,317.84. The other two members of the Board were not present, and drew no mileage. The mileage of the nine members of the Board of Visitors present in 1885 was $796.48. The other three members of the Board were not present, and drew no mileage.)		
	2,500 00	1
For purchase of chemicals, apparatus, and instruments in the department of physics and chemistry, and for repairs of the same (same act)	2,500 00	2
For purchase of gas and steam machinery, steam pipe and fittings, rent of buildings for the use of the Academy, freight, cartage, water, music, musical and astronomical instruments, uniforms for the bandsmen, telegraphing, for feed and maintenance of teams, for current expenses and repairs of all kinds, and for incidental labor and expenses not applicable to any other appropriation (same act)	34,600 00	34
For stores in the department of steam-engineering (same act)	800 00	
For materials for repairs in steam-machinery (same act)	1,000 00	1
For construction of a new set of quarters for cadets capable of accommodating three hundred cadets; to be built in accordance with general plan submitted to the Navy Department June 16, 1884 (submitted)	120,000 00	

tes of appropriations required for the service of the fiscal year, &c.—Continued.

Detailed objects of expenditure, and explanations.	Estimated amount which will be required for each detailed object of expenditure.	Amount appropriated for the current fiscal year, ending June 30, 1886.
FOR CONTINGENT EXPENSES—NAVAL ACADEMY—continued.		
main building, now occupied as quarters by the cadets, accom-es about three-quarters of the average number at the Academy, mainder being quartered in what are known as the "old quar-situated nearly one-quarter of a mile distant from the main build-This main building is unsuitable for cadet quarters, it is badly ed, badly ventilated, would be a dangerous building in case of badly located, the rooms are too small, and it contains the mess-ed kitchen, which cause the odors of food to pervade the building times.		
"old quarters" are too small, are in very bad condition, and l be rebuilt.—(See Reports of Boards of Visitors, 1883, 1884, and		
headstones for the graves of sixty (60) sailors and marines buried naval cemetery at the Naval Academy, Annapolis, Md., who eir lives by being wrecked in the U. S. S. Huron (submitted)	$500 00	

RECAPITULATION.

Detailed objects of expenditure, and explanations.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the current fiscal year, ending June 30, 1886.
f professors and others	$52,706 00	$53,559 00
f watchmen, mechanics, and others	45,899 95	37,602 45
f employés in department of steam-engineering	8,876 50	7,668 00
ary repairs to public buildings, &c	21,000 00	21,000 00
for heating and lighting Academy and school-ships	17,000 00	17,000 00
ase of books for the library	2,000 00	2,000 00
ery, blank books, maps, &c	3,000 00	2,000 00
ses of the Board of Visitors	2,500 00	1,500 00
ase of chemicals, &c	2,500 00	2,500 00
ase of gas and steam machinery, &c	34,600 00	34,600 00
s in the department of steam-engineering	800 00	800 00
rials for repairs in steam-machinery	1,000 00	1,000 00
	190,334 45	181,229 45
nstruction of new set of quarters for cadets	120,000 00	
stones for graves of wrecked sailors and marines	500 00	

spectfully submitted.

F. M. RAMSAY,
Captain U. S. Navy, Superintendent.

NITED STATES NAVAL ACADEMY,
September 26, 1885.

W. C. WHITNEY,
Secretary of the Navy, Washington, D. C.

No. 6.—BUREAU OF YARDS AND DOCKS.

BUREAU OF YARDS AND DOCKS,
NAVY DEPARTMENT,
Washington, D. C., October 13, 1885.

SIR: The following report of the work done under the cognizance of this Bureau for the fiscal year ending June 30, 1885, accompanied by (as part of this report) detailed statements of the expenditures, and the estimates in tabular form from the commandants of navy-yards for the fiscal year ending June 30, 1887, is herewith submitted.

These statements show a gross amount estimated for from the navy-yards as follows:

Improvements	$7,830,631 91
Repairs and preservation	1,224,600 62
Naval Asylum	96,661 00
Civil establishment	44,008 00
General maintenance	470,796 93
Grand total	9,666,698 47

The amount to be expended upon yards and stations will depend largely upon the policy which Congress may decide upon with regard to them.

In order that the matter may be fairly before it, I estimate for certain desirable improvements in addition to the necessary expenditures for repairs and preservation and maintenance.

The estimates of the Bureau are summarized as follows:

For support of Bureau of Yards and Docks	$11,960 00
For general maintenance and contingent	340,000 00
For support of Naval Asylum	96,661 00
For repairs and preservation	800,000 00
For improvements at navy-yards	3,768,337 41
For civil establishment	68,759 44
Total	5,085,737 85

The following tabulated statements show the amounts expended and estimates by the several navy-yards and stations and the Naval Asylum, under the principal heads of improvements, repairs and preservation, Naval Asylum (support of beneficiaries), civil establishment, general maintenance, and contingent, viz:

No. 1.—*Report of expenditures at navy-yards and stations and Naval Asylum for the year ending June* 30, 1885.

APPROPRIATIONS.

Yards and stations	Yard improvements.	Repairs and preservation.	General maintenance.	Closed navy-yards.	Civil establishment.	Contingent.	Total.
Portsmouth, N. H.		$18,959 81	$22,733 87		$3,474 55	$503 31	$45,671 [illegible]
Boston, Mass		3,698 22	30,258 65	$254 71	2,609 92		36,[illegible]
New London, Conn			1,766 21				3,766 [illegible]
New York, N. Y	$32,133 00	33,128 86	37,356 13		4,710 46		107,328 45
League Island, Pa		4,915 89	14,252 70		2,417 25		21,585 84
Washington, D. C	860 60	20,396 86	18,014 91		2,784 50	4,688 75	46,745 [illegible]
Norfolk, Va		31,332 41	24,306 80		2,920 88	3,404 01	61,964 10
Pensacola, Fla		680 44	11,948 77	69 47	944 39		13,643 07
Mare Island, Cal	242,821 27	19,173 06	34,028 97		3,580 03	3,821 03	303,[illegible]
Sackett's Harbor, N. Y			369 75				369 75
Key West, Fla		744 70	2,365 95				3,110 65
Naval Asylum, Pa	56,678 96						56,678 96
Wharf at Erie, Pa						500 00	500 00
Port Royal, S. C	771 11	38 12	123 47			51 70	984 [illegible]
Total	333,264 94	134,056 39	198,546 18	324 18	23,540 97	12,968 80	702,701 [illegible]

Objects.	Portsmouth.	Boston.	New York.	League Island.	Washington.	Norfolk.	Pensacola.	Mare Island.	Key West.	Port Royal.	Total.
Yard buildings	$2,386 56	$475 76	$13,249 16	$208 27	$7,389 89	$6,667 26	$51 51	$3,117 90	$744 70	$29 58	$34,320 59
Officers' quarters	1,363 29	900 42	3,214 52	25 11	2,912 83	377 45	172 74	617 29	....	8 54	9,592 19
Wharves, bridges, landings, and boats	598 31	....	1,473 69	279 53	317 55	2,230 59	226 84	3,770 49	....	....	8,897 00
Roads, walks, gutters, and drains	2,935 27	861 47	3,130 38	126 43	4,234 79	10,351 02	58 60	7,124 27	....	....	28,822 23
Fences and walls	352 44	6 56	244 68	20 59	1,004 60	266 35	85	892 79	....	....	2,788 86
Cranes, scows, and derricks	16 49	....	688 94	17 37	312 86	615 39	10 10	384 80	....	....	2,045 95
Furnaces, forges, heating apparatus, &c	2,027 62	37 08	527 43	18 20	298 15	687 00	....	40 00	....	....	3,635 48
Tracks and scales	169 00	....	471 29	....	603 19	16 30	3 82	182 90	....	....	1,446 50
Water and gas works	2,826 70	738 99	2,333 06	32 12	1,932 73	1,719 17	....	2,968 71	....	....	12,551 48
Dredging and scowing	....	67 80	3 00	....	490 99	271 42	....	....	....	....	883 21
Dry-docks	251 35	138 12	517 26	....	....	1,442 28	63 84	....	....	....	2,412 85
Miscellaneous repairs	6,032 81	460 02	7,275 45	2,826 02	899 28	7,688 18	92 14	73 90	....	....	25,347 80
Repairs to dikes	....	....	....	1,362 25	....	....	....	....	....	....	1,362 25
Total	18,959 84	3,686 22	33,128 86	4,915 89	20,396 86	32,332 41	680 44	19,173 05	744 70	38 12	134,056 39

No. 3.—*Detailed report of expenditures under "general maintenance" received from yards and stations during the fiscal year ending June 30, 1885.*

Objects.	Portsmouth.	Boston.	New London.	New York.	League Island.	Washington.	Norfolk.	Pensacola.	Mare Island.	Key West.	Sackett's Harbor.	Port Royal.	Total.
Freight and transportation		$175 00	$14 00	$890 42	$24 00				$2,563 82				$3,667 24
Printing, stationery, and advertising	$493 19	329 09	19 79	725 53	396 90	$388 44	$456 96	$22 50	722 16	$30 50		$63 75	3,678 83
Books, maps, models, and drawings						13 75	145 25						159 00
Purchase and repair of fire-engines	75	21 60		291 64	30 00	75	30 23	1,523 17	22 61	955 00			2,785 76
Machinery of every description and patent rights				1 57	103 11	5 28	195 40	36 56	291 72				634 64
Repairs on steam fire-engines and attendance on same	31			1,381 37	19 55		566 48	160 10					2,127 81
Purchase and maintenance of oxen, horses, pay of hired teams, tugs, &c	4,089 92	3,163 53	720 42	6,038 42	4,353 98	2,998 95	2,806 82	2,181 64	5,196 70				31,450 42
...rts, timber-wheels, and tools of every description	397 40	94 38		1,381 05	1,044 71	329 41	401 17	233 54	213 93				4,095 59
...age on letters in public service and telegrams	124 00	20 00	6 00	12 72	188 83	19 21	76 91		1,128 32				1,575 99
...iture for Government houses and offices in navy-yards	419 79	39 55		67 51	74 64	73 70	151 29	10 59				10 75	847 82
...nd other fuel for yards and docks purposes	2,945 74	3,184 38		3,114 04	467 76	1,318 46		145 59	99 75				11,275 72
...s, oil, and gas	661 01	877 62	10 00	2,750 84	111 09	810 60	2,918 22	250 44	5,084 85	29 50		48 97	13,553 14
...ning and clearing up yards and care of buildings	597 05	4,475 76	180 00	4,904 19	319 27	3,220 04	988 64	462 73	4,388 31				19,535 99
...dance on fires, lights, fire-engines and apparatus	1,341 96	2,080 52		4,357 27	2,831 36	1,370 58	869 25	342 50	2,740 28				15,938 72
...ntal labor not chargeable to other appropriations	3,983 53	2,290 36	626 00	175 62	1,674 01	2,174 51	1,675 55	2 77	1,578 65		389 75		14,570 75
...tax	100 00	3,205 76		4,774 94			50 91	33 60	4,999 93	52 20			13,217 34
...and ferriages	4 32	509 90		107 50			197 50		2,760 00				3,579 22
... watchmen	7,487 40	9,087 48	2,150 00	6,353 00	1,448 00	5,333 62	11,734 80	6,543 00	2,160 50	1,298 75			53,636 55
...s, awnings, and packing-boxes	12 50	703 72		118 50	23 84	57 60	10 40		77 44				1,004 00
...s of landings	75 00												75 00
... of officers' quarters at Philadelphia					1,141 65								1,141 65
Total	22,783 87	30,258 65	3,766 21	37,356 13	14,252 70	18,014 91	23,306 80	11,948 77	34,028 97	2,365 95	389 75	123 47	198,546 18

No. 4.—*Detailed report of expenditures under "closed navy-yards" received from yards during the fiscal year ending June* 30, 1885.

Object.	Boston.	Pensacola.	Total.
REPAIRS AND PRESERVATION.			
Yard buildings	$66 31		$66 31
Officers' quarters	52 44		52 44
Wharves, bridges, landings, and boats	18 42		18 42
Water and gas works	80 29		80 29
Miscellaneous repairs	37 25	$22 74	59 99
Total	254 71	22 74	277 45
GENERAL MAINTENANCE.			
Incidental labor not chargeable to other appropriations		46 73	46 73
Total		69 47	324 18

No. 5.—*Estimates received from navy-yards and Naval Asylum for the fiscal year ending June* 30, 1887.

APPROPRIATIONS.

Yards and stations.	Yard improvements.	Repairs and preservation.	General maintenance.	Civil establishment.	Total.
Portsmouth, N. H	$9,500 00	$87,000 00	$51,340 00	$3,400 00	$151,240 00
Boston, Mass	2,852,521 30	240,569 85	74,800 00	7,256 25	3,175,147 40
New London, Conn		1,200 00	5,650 00		6,850 00
New York, N. Y	1,239,635 50	531,185 80	129,400 00	6,500 00	1,906,721 30
League Island, Pa	1,536,366 42	69,282 55	44,807 76	9,700 00	1,660,156 73
Washington, D. C	116,711 00	54,250 00	40,915 00	3,717 25	215,593 25
Norfolk, Va	1,545,116 92	92,124 90	50,000 00	5,334 50	1,692,576 32
Pensacola, Fla		31,886 10	14,373 82	1,200 00	47,459 92
Mare Island, Cal	497,260 90	101,162 79	56,234 85	6,900 00	661,558 54
Sackett's Harbor, N. Y		1,000 00			1,000 00
Key West, Fla	15,000 00	14,629 70	2,898 00		32,527 70
Naval Asylum, Pa	96,661 00				96,661 00
Port Royal, S. C	18,519 87	308 94	377 50		19,206 31
Total	7,927,292 91	1,224,600 63	470,796 93	44,008 00	9,666,698 47

No. 6.—*Detailed estimates from yards and stations for works of improvement for the fiscal year ending June* 30, 1887.

Yards, stations, and objects.	Estimates.	Total.
PORTSMOUTH, N. H.		
For cleaning three ponds	$3,000 00	
For proposed reservoir	6,000 00	
For piping	500 00	
		$9,500 00
BOSTON, MASS.		
For iron-plater's shop	120,713 89	
For water-pipes	49,607 00	
For cart-shed	10 408 45	
For erecting and copper shop	39,864 90	
For paving and grading	43 109 40	
For floating-gate, dry-dock (iron)	30,762 88	
For officers' quarters, L, M, N, and O	28,610 00	
For rebuilding wharves	74,244 78	
For additional dry-docks	2,455,200 00	
		2,852,521 30
NEW YORK, N. Y.		
For general storehouse for yards and docks	84,752 00	
For general paint and oil storehouse	53,491 50	
For boiler-shop wing to machine-shop	73,000 00	
For repairs to dry-dock	125,000 00	
For repairs to cob-dock	255,750 00	
For one timber dry-dock	600,000 00	
For beef and pork packing-house	47,642 00	
		1,239,635 50

No. 6.—*Detailed estimates from yards and stations for works of improvement, &c.*—C

Yards, stations, and objects.	Estimates.	Tot
LEAGUE ISLAND, PA.		
For storehouse for ordnance	182,414 47	
For storehouse for provisions and clothing	209,237 84	
For storehouse for equipment and recruiting	209,237 84	
For office building for yard paymaster	19,579 29	
For office building for medicine and surgery	19,579 29	
Eor office building for commandant	53,735 59	
For dwellings B and C	30,582 85	
For dwellings D and E	30,582 85	
For landing-wharf foot of Fifteenth street (dimensions, 75 by 400 feet)	26,416 40	
For dredging and filling in	155,000 00	
For timber dry-dock (525 feet by 118 feet 4 inches by 33 feet 8 inches)	600,000 00	
		1,536
WASHINGTON, D. C.		
For new ordnance machine-shop	95,000 00	
For extension of yard wall through marsh	21,711 00	
		116
NORFOLK, VA.		
For dry-dock	500,000 00	
For dry-dock pumps	52,600 00	
For extension of quay wall	384,400 00	
For railroad extension	47,479 87	
For electric lights	17,600 00	
For erecting shop No. 41	34,073 45	
For iron and steel construction shop	41,699 00	
For paint-shop	32,986 60	
For extension of boiler-shop	14,488 29	
For floating derrick	49,189 71	
For navy-yard extension	358,600 00	
For two officers' quarters	12,000 00	
		1,545
PORT ROYAL, S. C.		
For combined coal-shed and storehouse	10,982 60	
For boat-house	126 20	
For artesian well	592 20	
For flag-staff	93 80	
For quarters for commanding officer	6,725 07	
		18
KEY WEST, FLA.		
For purchase of Mallory lot	15,000 00	
		15
MARE ISLAND, CAL.		
For continuation of stone dry-dock	191,595 00	
For timber-shed	13,085 05	
For cisterns	46,346 30	
For rolling-mill for steam-engineering	40,000 00	
For boiler-shop for steam-engineering	4,200 00	
For wharves	110,743 81	
For landings	5,000 00	
For roads	42,517 50	
For gate and guard-house	20,000 00	
For gas-holder	16,664 09	
For gas mains and pipes	3,109 15	
For iron-plating shop	4,000 00	
		497
NAVAL ASYLUM, PHILADELPHIA.		
For support of beneficiaries, improvements, and all expenses	96,661 00	
		96
Total		7,927

Objects.	Portsmouth.	Boston.	New London	New York.	League Island.	Washington.	Norfolk.	Pensacola.	Mare Island.	Sackett's Harbor.	Key West.	Port Royal.	Total.
Yard buildings	$40,000 00	$121,036 58	$800 00	$317,644 00	$13,367 75	$15,000 00	$42,929 98	$5,158 42	$14,314 87	....	$8,211 70	$190 39	$578,148 14
Officers' quarters	8,000 00	3,000 00	300 00	6,000 00	169 25	2,000 00	....	2,867 46	2,154 00	....	....	35 55	24,526 26
Wharves, bridges, landings, and boats	8,000 00	25,000 00	200 00	43,816 00	20,765 75	1,500 00	15,720 97	4,571 00	3,726 62	....	2,600 00	....	125,900 34
Roads, walks, gutters, and drains	4,000 00	22,500 00	100 00	139,425 80	1,260 00	5,000 00	11,910 00	516 60	7,200 00	....	....	....	191,912 40
Fences and walls	800 00	5,000 00	150 00	4,986 00	252 30	1,000 00	....	2,096 14	1,500 00	....	....	....	15,784 44
Cranes, scows, and derricks	6,000 00	15,000 00	....	1,214 00	1,655 50	500 00	4,000 00	298 32	500 00	....	....	....	29,167 82
Furnaces, forges, heating apparatus, &c	2,500 00	1,000 00	50 00	7,000 00	552 00	750 00	....	303 75	1,500 00	....	....	33 00	13,688 75
Tracks and scales	200 00	10,000 00	....	100 00	1,260 00	2,500 00	3,164 00	....	2,326 80	....	1,702 00	....	21,252 80
Water and gas works	2,500 00	2,000 00	....	6,000 00	....	3,000 00	4,300 00	97 25	1,000 00	....	....	....	18,897 25
Dredging and scowing	....	5,000 00	....	....	....	20,000 00	5,300 00	15,697 20	4,441 00	....	....	....	50,438 20
Dry-docks	10,000 00	21,033 27	....	....	....	....	1,300 00	....	*60,000 00	....	....	....	92,333 27
Miscellaneous repairs	5,000 00	10,000 00	100 00	5,000 00	....	3,000 00	3,500 00	284 96	2,500 00	$1,000 00	1,000 00	50 00	31,434 96
Dikes	....	....	....	....	30,000 00	....	....	....	....	....	....	....	30,000 00
Cistern	....	....	....	....	....	....	....	....	....	....	1,116 00	....	1,116 00
Total	87,000 000	240,569 85	1,200 00	531,185 80	69,282 55	54,250 00	92,124 90	31,886 10	101,162 79	1,000 00	14,629 70	308 94	1,224,600 63

* Sectional.

No. 8.—*Detailed estimates for "general maintenance" received from yards and stations for the fiscal year ending June 30, 1887.*

Objects.	Portsmouth	Boston.	New London	New York.	League Island.	Washington.	Norfolk.	Pensacola.	Mare Island.	Key West.	Port Royal.	Total.
Freights and transportation	$100 00	$200 00	$25 00	$1,000 00	$100 00	$15 00	$100 00		$3,000 00	$150 00	$10 00	$4,700 00
Printing, stationery, and advertising	600 00	500 00	100 00	1,000 00	1,000 00	500 00	300 00	$157 50	1,000 00	60 00	100 00	5,317 50
Books, maps, models, and drawings	100 00	100 00		2,200 00	500 00	50 00	1,000 00				15 00	3,965 00
Purchase and repairs of fire-engines	2,000 00	1,000 00		5,000 00	342 10	5,500 00	5,000 00	126 00	500 00			19,468 10
Machinery of every description and patent rights	600 00	500 00		9,000 00	1,745 00	500 00	3,500 00		300 00			16,145 00
Repairs on steam fire-engines and attendance on same	500 00	2,500 00		3,500 00	1,197 20	500 00	1,000 00	101 00	1,500 00			10,798 20
Purchase and maintenance of horses and oxen and pay of hired teams, &c	6,000 00	16,000 00	775 00	14,000 00	8,055 00	5,000 00	5,000 00	1,608 70	6,000 00			61,438 70
Carts, timber-wheels, and tools of every description	4,000 00	8,500 00	200 00	10,000 00	4,821 76	2,000 00	4,000 00	524 90	1,000 00		30 00	35,076 66
Postage on letters on public service, and telegrams	200 00	100 00	20 00	200 00	300 00	50 00	20 00		1,500 00		5 00	2,395 00
Furniture for Government houses and offices in navy-yards	2,500 00	1,500 00		7,500 00	2,395 00	3,000 00	3,960 00	69 90	4,300 00	50 00	25 00	25,309 90
Coal and other fuel for yards and docks purposes	5,000 00	4,000 00	100 00	5,000 00	3,850 00	2,000 00	1,000 00	164 00	800 00		110 00	22,024 00
Candles, oil, and gas	5,000 00	3,000 00	40 00	4,000 00	246 50	1,200 00	2,000 00	319 00	5,084 85	25 00	92 50	21,007 85
Cleaning and clearing up yards and care of buildings	6,000 00	15,000 00		25,000 00	4,200 00	5,000 00	3,000 00	1,227 87	6,000 00			65,427 87
Attendance on fires, lights, fire-engines, and apparatus	5,000 00	3,700 00		6,000 00	4,200 00	2,500 00	5,000 00	2,363 50	3,000 00			31,763 50
Incidental labor not chargeable to other appropriations	6,500 00	2,000 00	2,000 00	8,000 00	3,850 00	5,000 00	5,000 00		2,000 00			34,350 00
Water tax	100 00	5,000 00		7,000 00				50 40	5,000 00	73 00		17,223 40
Tolls and ferriages	50 00		40 00	500 00					3,000 00			3,590 00
Pay of watchmen	6,840 00	12,000 00	2,300 00	20,000 00	7,300 00	6,000 00	10,000 00	7,578 00	12,000 00	2,490 00		68,508 00
Flags, awning, and packing-boxes	250 00	200 00	50 00	500 00	705 20	100 00	100 00	63 75	250 00	50 00		2,268 95
Total	51,340 00	74,800 00	5,650 00	139,400 00	44,807 76	40,915 00	50,000 00	14,373 62	56,234 85	2,898 00	377 50	470,796 98

The very limited appropriations made for the care and maintenance of yards the past few years has necessarily resulted in such a condition of decay in buildings, docks, and wharves that in order to put them in proper condition a liberal appropriation is absolutely necessary under the general heads of "maintenance" and "repairs and preservation," more particularly under the latter. Scarcely a week has passed since I assumed control of the Bureau that reports have not been received of buildings tumbling down, or liable to do so at any moment, roofs leaking to such an extent as to involve destruction of property, and in rainy weather preventing men from working; wharves rotten and falling into the water; others so defective that they cannot be used; stone dry-docks having to be shored up with timber, roads and ways broken in and in bad condition; water service defective on account of worn-out pipes, and a complaint of decay that implies general destruction.

It surely must appear to Congress that these vast establishments, such as our navy-yards are, cannot be kept in proper condition, available for the needs of the country, without sufficient means to repair the wharves and buildings so that they can be used at all times for the purpose intended. Much is yet to be done in the way of improvements to make any of our yards equal to all the demands that may be made upon them.

The appropriations have generally been well expended, but they have been so very small that little could be done.

There are in the different yards five hundred and five buildings of various sizes, some of them covering as much as 40,000 square feet of ground, and three stories high; in addition to these are several miles of wharves, besides stone dry-docks, with their appurtenances. Many of these buildings were built fifty to sixty years ago, and are from their age and want of care, consequent upon the need of funds, in a dilapidated condition. For the care of this vast amount of property only $125,000 has been appropriated for the last two years; and considering that owners of property estimate that at least 1 per cent. of the value of a building is necessary every year to keep it in proper order, and that this property is worth not less than $50,000,000, and could not be replaced for that sum, it at once appears how inadequate the appropriations have been.

Not less than $800,000 should be appropriated yearly for the next three years to put the property in good condition, and I sincerely hope that this amount may be given.

Under the heads of the different yards I will respectfully offer my views on such of the estimates as seem to me deserving particular notice.

NAVY-YARD, PORTSMOUTH, N. H.

The floating dry-dock at this yard requires extensive repairs, and under the head of "repairs and preservation" $10,000 is asked for this purpose. This sum is necessary to put it in serviceable condition, and I request that this amount may be made a special appropriation, in order that work may be commenced as early as possible.

The sum of $9,500 is asked for under the head of improvements, to perfect the water system, now in the most defective condition.

NAVY-YARD, BOSTON, MASS.

The following items of improvements in this yard are considered ablutely necessary, viz: A renewal of water-pipes, for which $49,607 is uired; for a new cart-shed, $4,000; floating gate for dry-dock,

$30,762.88; repairs of officers' quarters, $11,000; and repairs of wharves, $50,000; amounting in the aggregate to $145,369.88.

The necessity for a new floating gate for the dry-dock is absolute. The present caisson is of wood, and is in such bad condition that further repairs upon it are almost impossible.

The necessity for new water-pipes is also very great. Those now in use are constantly bursting, involving great waste.

The wharves, with one exception, are so rotten that they cannot be used, it being deemed dangerous for persons even to walk over them for fear of falling through.

NAVAL STATION, NEW LONDON, CONN.

No work of any kind has been done at this station during the fiscal year, and only such expenditure has been made as was absolutely necessary to care for public property and keep up communication between the station and New London.

I respectfully renew the recommendation of the former chief of this Bureau, Admiral Nichols, that if "nothing is to be done to improve this station, all the portable property be transferred to other yards or sold."

NAVY-YARD, NEW YORK.

The only work of improvement at this yard during the past year has been dredging the channel.

A contract was entered into for repairs to that portion of the cob-dock which most required it for $47,574.26, and that work is now in progress.

Estimates for "improvements" are submitted and strongly urged for the following, viz:

A new dry-dock, $700,000; repairs to and lengthening present stone dry-dock, $331,000; boiler-shop wing to machine-shop, $73,000, this amount to be made a special appropriation and immediately available; repairs to cob-dock, $50,000; and for paint and oil storehouse $25,000.

A new dry-dock at this yard is essential. The present dock is too short for the largest ships, and the masonry work is in such a shocking condition as to involve the necessity of using timber shores to keep the granite blocks from falling in. An estimate of $700,000 is presented for the construction of a Simpson dock, to be built of timber. This amount would build a dock on an improved plan about 480 feet in length. In case this amount is appropriated and a new dock authorized to be built, the present dock would not require lengthening, and in that case $155,000 would be sufficient to repair it and give a new caisson.

The estimate of $50,000 for the cob-dock is to renew the crib-work where it is most defective. Within the past three months about 200 feet of defective crib-work gave way, owing to its rotten condition, and fell into the water.

The estimate for a paint and oil storehouse I most strongly urge in order that there may be some place where inflammable articles can be stored without danger from fire to the many valuable buildings in the yard, with their contents.

NAVY-YARD, LEAGUE ISLAND, PA.

This yard has been practically closed during the past year, and only so much of the appropriations expended as was absolutely necessary.

If the yard is to be improved and made available for work on vessels,

I would respectfully suggest that the following amounts be appropriated:

For office-building for commandant	$15,000 00
For officers' quarters	36,000 00
For landing-wharf, foot Fifteenth street	26,416 40
For building Simpson dry-dock (timber)	700,000 00
For dredging and filling in	155,000 00
An aggregate of	932,416 40

To make the plant now in the yard available for repairs of ships, a Simpson dry-dock is suggested as a necessity. Such a dock will cost about $700,000, and would require about two years to complete.

NAVY-YARD, WASHINGTON, D. C.

At this yard no works of improvement have been undertaken. The small amounts appropriated for "repairs and preservation" and "general maintenance" have been economically expended.

The only improvements recommended are a new ordnance machine-shop and the extension of the yard wall; for the first, $95,000, and the latter, $21,711.

NAVY-YARD, NORFOLK, VA.

No works of improvement have been undertaken at this yard.

The expenditures under appropriation "repairs and preservation" were $32,332.41, and under "general maintenance" $23,306.80.

The very limited appropriations prevented necessarily the needed repairs being made in many of the buildings which should have been provided for.

The estimates of this yard for improvements recommended amount to $1,545,116.92.

As this yard is of equal importance to any on the Atlantic coast, the expenditure of large amounts for its improvements is warranted, so that it may in all respects be put in the condition for carrying on all kinds of work of a first-class naval establishment.

Owing to its natural advantages in climate and location, it is especially recommended to the favorable consideration of Congress.

Among the many improvements suggested in the commandant's annual report, the Bureau specially commends as worthy of favorable consideration the following objects, which are regarded as essentially necessary, viz:

Dry-dock (timber)	$650,000 00
Pumps for dry-dock	52,600 00
Extension of quay wall	140,000 00
Railroad extension	47,479 87
Electric lights	17,600 00
Floating derrick	49,189 71
Two officers' quarters	12,000 00
Ordnance wharf at Saint Helena	15,000 00
Total	983,869 58

Another very important improvement, though not mentioned in the foregoing, is the extension of the present stone dry-dock, for which an appropriation of $240,000 should be provided for.

The dry-dock, a stone structure, is in good condition, but, owing to its want of sufficient length, is not adequate to the future needs of the

service. This is the only dry-dock on the entire coast from Norfolk to the Rio Grande in which a ship of 300 feet length can be docked; and as it is contemplated to build ships in the future of greater length than this, and as those ships built of steel will require more frequent docking, owing to the readiness with which they foul, it is deemed eminently necessary that in addition to the extension of the stone dock at this yard a new dock of not less than 500 feet in length should be constructed on the "Simpson plan," that will answer for docking vessels of the length they are likely to be built.

The new pumps for the present dry-dock can be made available for the old dock as well as the new one.

An appropriation for the floating derrick is also urged upon Congress as a great necessity, considering the extended water front.

The extension of the railroad system is deemed of great importance in the interests of economy in money and a great saving in time. In these days of progress it appears absurd to see large weights such as boilers, guns, machinery, &c., hauled over plain roads by teams of oxen numbering from six to ten, at an expense that may well be avoided. It is therefore hoped that Congress will see the necessity of granting the appropriation asked for to extend the railroad system of the yard and thereby do away with the present expensive methods of carrying on the heavy transportation.

The other objects estimated for at this yard, but not particularly noted, are of great need and of equal importance to those specially dwelt upon, and it is the desire of the Bureau that they be appropriated for.

The commandant has estimated for $92,124.90 under "repairs and preservation," and $50,000 under "general maintenance."

NAVY-YARD, PENSACOLA, FLA.

This yard has been closed for all general work, and only the amount necessary to care for public property has been expended.

No expenditure is specially recommended for this yard. Under the general head of "repairs and preservation" expenditures will be made for the care of public property only as the necessity arises.

NAVAL STATION, KEY WEST, FLA.

The estimates for "repairs and preservation" at this yard are under the general head of appropriation for that purpose, and are only for possible contingencies that may arise involving expenditures to keep the public property in good order.

NAVY-YARD, MARE ISLAND, CAL.

I regret to say that the work on the stone dock has not progressed as rapidly as it should have done, owing to the necessity of taking so large an amount of the appropriation for the pumps. They are now being rapidly put in position, and when completed, which I hope will be by the 1st of February next, the dock will be ready for use, although not entirely completed.

The sum of $191,595 is estimated for to finish it up, and I have to request that this amount be made immediately available, in order that there may be no delay in completing this important work and its surroundings.

Appropriations are asked for for the following additional items: Cis-

ıs, $46,346; boiler-shop for steam-engineering, $4,200; wharves and ıdings, $115,743.81; roads, $15,000; gas-holder, $16,664; gas mains pipes, $3,109.15; and iron-plating shop, $4,000.

NAVAL STATION, PORT ROYAL, S. C.

The wharf at this station is nearly completed. Estimates are respectfully presented for $4,000 for building a coal-shed and storehouse; $592.20 for boring an artesian well; $93.80 for flagstaff; and $126.20 for a boat-shed.

NAVAL ASYLUM, PHILADELPHIA, PA.

The expenditures at this institution for the fiscal year ending June 30, 1885, are as follows:

Pay and pocket-money of beneficiaries	$4,236 60
Tobacco	843 20
Clothing, boots and shoes	8,101 10
Subsistence	19,516 74
Paints, dry goods, lumber, coal, wood, provender, hardware, miscellaneous and house sundries	8,517 55
Total for support of beneficiaries	41,215 19
Pay of employés	8,502 99
Repairs and preservation of all kinds, painting, and for grates, furnaces, ranges, furniture and repairs of furniture	4,398 28
Water-rent and gas	1,521 41
Cemetery and burial expenses and head-stones	217 82
Improvement of grounds	498 75
Car-tickets	150 00
Ice	174 52
Total	56,678 96

Estimates are respectfully submitted for the Naval Asylum for the fiscal year ending June 30, 1887, as follows, viz:

Pay and pocket-money for beneficiaries	6,600 00
Clothing, boots and shoes	10,000 00
Tobacco	1,200 00
Provisions	24,000 00
Ice	400 00
Coal and wood	3,000 00
Dry goods, paints, lumber, provender, hardware, miscellaneous and house sundries	8,000 00
Total support of beneficiaries	53,200 00
Pay of employés	10,061 00
Water-rent and gas	1,800 00
Cemetery, burial expenses, and head-stones	350 00
Improvement of grounds	500 00
Repairs to buildings, furnaces, grates and ranges, furniture and repairs to furniture	8,000 00
Car-tickets	150 00
Music in chapel	600 00
Erecting brick building in rear of main building for kitchen, laundry, and servants' quarters	20,000 00
Fitting up bath-rooms with twelve tubs for beneficiaries' use	800 00
Removing laundry boilers and tubs to new building, and plumbing	400 00
Kitchen-range for new building	800 00
Total estimates for all purposes	96,661 00

There were on the rolls of this institution July 1, 1884, the names of 196 beneficiaries. During the fiscal year ending June 30, 1885, 23 have been admitted, 12 have died, and 5 have been dropped for continued absence without leave, 2 have been discharged at their own request, and 1 has been dismissed for misconduct, leaving on the rolls July 1, 1885, the names of 199 beneficiaries.

The general standing and character of the beneficiaries during the past year have been improved, and it gives me great pleasure to report this fact.

The general character of stores, provisions, and groceries furnished by the contractors has been good, and articles offered are rarely rejected by the inspecting officers.

The appropriation of money under the head of repairs of all kinds, &c., has been judiciously expended.

The present kitchen is utterly inadequate to its purpose; the mess-room of the beneficiaries is too small and overcrowded; the female attendants are lodged in the same corridors as the men, with only a light lattice door for separation; the matron has no suitable quarters, and there is not a single convenience for the beneficiaries or female attendants to bathe their persons.

The remedy for all these defects is to be found only in the erection of a new brick kitchen in the rear of the main building, to be provided with a coal-cellar, rooms for matron and her female attendants, and wash-room for the cooks, with laundry included; this will enable the mess-room to be enlarged by throwing the present laundry into it, and a bath-room for beneficiaries to be made out of the present wash-room.

As time passes extensive repairs are needed. New floors to the verandas and lower corridors are required; and if a new kitchen is not built the old one should be tiled throughout, and a new set of ranges must ere long be supplied.

There is only one clerk allowed to this institution, and his labors are often prolonged over the Sabbaths, and late at night. I specially recommend that an increase of salary be allowed to this much overworked and competent employé to the same grade as that of the commandant's clerk at the Mare Island navy-yard, $1,800 per annum.

Attention is invited to the fact that when a pensioner enters this institution his pension is stopped and is covered in the hospital fund.

Inasmuch as these pensions are drawn from the "naval pension fund" in the Treasury, and this institution for these retired seamen is also supported out of that fund, it does not appear otherwise than just that these pensions should revert to the "naval pension fund," whence they are drawn. As it is now, the "naval pension fund" is undergoing depletion to build up and swell the "hospital fund." I submit that is a grave error.

An increase in the police force of the institution by the addition of one house corporal, and for advancing of the matron to $40 per month, of the steward and master-at-arms to $50 per month each, and of the house corporal to $30.

CONTINGENT.

The sum required under this head, viz, $40,000, is to meet unforeseen emergencies that may arise, calling for immediate outlay that has not been provided for.

GENERAL MAINTENANCE.

The most pressing and necessary expenditures of the different yards come under this head, such as repairs of fire-engines, purchases of horses

and oxen and maintenance of same, carts and tools, telegrams, coal, water, and gas, incidental labor, pay of watchmen, cleaning yards, and care of buildings, purchase of and care of machinery of every description, rents, &c., and all sundry expenses. The need for the amount ($300,000) estimated is obvious and earnestly recommended.

The entire amount asked for by the Bureau is $5,085,737.85, the detail of which is contained on tabulated sheets Nos. 1 to 6, inclusive, recapitulated as follows:

RECAPITULATION OF ESTIMATES.

Sheet No. 1.	For support of Bureau of Yards and Docks	$11,980 00
Sheet No. 2.	For general maintenance and contingent	340,000 00
Sheet No. 3.	For support of Naval Asylum	96,661 00
Sheet No. 4.	For repairs and preservation	800,000 00
Sheet No. 5.	For improvements at navy-yards	3,768,337 41
Sheet No. 6.	For civil establishment	68,759 44
	Total	5,085,737 85

Detailed estimates of appropriations required for the service of the fiscal year ending June 30, 1887, by the Bureau of Yards and Docks, Navy Department.

Detailed objects of expenditure, and explanations.	Estimated amount which will be required for each detailed object of expenditure	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the current fiscal year ending June 30, 1886
SALARIES.			
One chief clerk, March 3, 1885	$1,800 00		
One draughtsman and clerk (same act)	1,800 00		
One clerk of class four (same act)	1,800 00		
One clerk of class three (same act)	1,600 00		
One clerk of class two (same act)	1,400 00		
One clerk of class one (same act)	1,200 00		
One clerk (same act)	1,000 00		
One messenger (same act)	720 00		
One laborer (same act)	660 00		
An increase of $600 to salary of chief clerk is submitted.		$11,980 00	$11,980 00
GENERAL MAINTENANCE.			
For general maintenance of yards and docks, namely: For freights and transportation of materials and stores; books, maps, models, and drawings; purchase and repair of fire-engines, machinery; repairs of steam fire-engines, and attendance on the same; purchase and maintenance of oxen and horses and driving teams, carts, and timber wheels, and all vehicles for use in the navy-yards, and tools and repairs of the same; postage on letters and other mailable matter on public service, and telegrams; furniture for Government houses and offices in navy-yards; coal and other fuel, candles, oil and gas; cleaning and clearing up yards, and care of public buildings; attendance on fires, lights, fire-engines and apparatus; for clerical and incidental labor at navy-yards; water-tax, and for tolls and ferriages; rent of four officers' quarters at Philadelphia; for rent of eight officers' quarters in Washington; pay of watchmen in the navy-yards; and for awnings and packing-boxes and advertising for yards and docks purposes (March 3, 1885)	300,000 00	300,000 00	200,000 00
CONTINGENT.			
For contingent expenses that may arise at navy-yards and stations (March 3, 1885)	40,000 00	40,000 00	20,000 00
	340,000 00	340,000 00	220,000 00

Detailed estimates of appropriations required, &c.—**Continued.**

Detailed objects of expenditure, and explanations.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the current fiscal year
NAVAL ASYLUM, PENNSYLVANIA.			
One superintendent (March 3, 1885)	600 00		
One steward, increase of $120, submitted (same act)	600 00		
One matron, increase of $120, submitted (same act)	480 00		
One chief cook, increase of $120, submitted (same act)	360 00		
Two assistant cooks, increase of $72 each, submitted (same act)	480 00		
One chief laundress (same act)	192 00		
Six laundresses, at $168 each (same act)	1,008 00		1
Four scrubbers, at $168 each* (same act)	672 00		2
Eight waiters, at $168 each* (same act)	1,344 00		
Six laborers, at $240 each (same act)	1,440 00		1
One stable-keeper and driver (same act)	360 00		
One master-at-arms, increase of $120, submitted (same act)	600 00		
Two house corporals, at $360 each (same act). Increase of one corporal at $360 and increase of pay of other, $60 (submitted).	720 00		
One barber (same act)	360 00		
One carpenter (same act)	845 00		
		10,061 00	
For water rent and gas (same act)	1,800 00		2
For cemetery burial expenses and head-stones (same act)	350 00		
For improvement of grounds (same act)	500 00		
For repairs to buildings, furnaces, grates, and ranges; furniture, and repairs of furniture (same act)	8,000 00		4.
For car-tickets (submitted)	150 00		
For music in chapel (submitted)	600 00		
		11,400 00	
For erecting brick building in rear of main building for kitchen, laundry, and servants' quarters (submitted)	20,000 00		
For fitting up bath-rooms with twelve tubs for use of beneficiaries (submitted)	800 00		
For removing laundry boilers and tubs to new building, and plumbing	400 00		
For kitchen range for new building	800 00		
For support of beneficiaries (same act)	53,200 00		
		75,200 00	43.
		96,661 00	59.
REPAIRS AND PRESERVATION.			
For navy-yards and stations (March 3, 1885)	800,000 00	800,000 00	125.
FOR NAVY-YARDS AND STATIONS.			
Navy-yard, Portsmouth, N. H.:			
For water supply (submitted):			
For cleaning three ponds (submitted)	3,000 00		
For building reservoir (submitted)	6,000 00		
For piping for same (submitted)	500 00		
		9,500 00	
Navy-yard, Boston, Mass.:			
For water-pipes and laying of same (submitted)	49,607 00		
For cart-shed (submitted)	4,000 00		
For floating gate for dry-dock, iron (submitted)	30,762 88		
For officers' quarters, L, M, N, and O (submitted)	11,000 00		
For rebuilding wharves (submitted)	50,000 00		
		145,369 88	
Navy-yard, Brooklyn, N. Y.:			
For general paint and oil storehouse (submitted)	25,000 00		
For boiler-shop wing to machine-shop (submitted)	73,000 00		
For repairs to dry-dock and extension (submitted)	331,000 00		
For repairs to cob-dock (submitted)	50,000 00		
For building dry-dock, timber (submitted)	700,000 00		
For dredging (March 3, 1885)			
		1,179,000 00	

*Formerly twelve scrubbers and waiters, at $168 each.

Detailed estimates of appropriations required, &c.—Continued.

Detailed objects of expenditure, and explanations.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the current fiscal year, ending June 30, 1886.
FOR NAVY-YARDS AND STATIONS—continued.			
vy-yard, League Island, Pa.:			
For office building for commandant (submitted)	15,000 00		
For dwelling B, C, D, and E	86,000 00		
For landing wharf, foot of Fifteenth street	26,416 40		
For building a Simpson dry-dock (timber)	700,000 00		
For dredging and filling in	156,000 00		
		983,416 40	
vy-yard, Washington, D. C.:			
For new ordnance machine-shop (submitted)	95,000 00		
For extension of yard wall (submitted)	21,711 00		
		116,711 00	
Navy-yard, Norfolk, Va.:			
For building dry-dock, timber (submitted)	650,000 00		
For pumps for dry-dock (submitted)	52,600 00		
For extension of quay wall (submitted)	140,000 00		
For railroad extension (submitted)	47,479 57		
For electric lights (submitted)	17,600 00		
For floating derrick (submitted)	49,189 71		
For two officers' quarters (submitted)	12,000 00		
For ordnance wharf at St. Helena (submitted)	15,000 00		
		983,869 28	
Navy-yard, Mare Island, Cal.:			
For continuation of stone dry-dock, $191,595, March 3, 1885 (submitted)	191,595 00		220,000 00
For cisterns (submitted)	46,346 30		
For boiler-shop for steam-engineering (submitted)	4,200 00		
For wharves (submitted)	110,743 81		
For landings (submitted)	5,000 00		
For roads (submitted)	15,000 00		
For gas-holder (submitted)	10,664 09		
For gas mains and pipes (submitted)	3,109 15		
For iron-plating shop (submitted)	4,000 00		
		390,658 35	
For artesian well (March 3, 1885)			10,000 00
For iron crane (same act)			40,000 00
For sewerage system (same act)			6,000 00
val station, Port Royal, S. C.:			
For combined coal-shed and store-house (submitted)	4,000 00		
For boat-house (submitted)	126 20		
For artesian well (submitted)	692 20		
For flag-staff (submitted)	93 80		
		4,912 20	
		3,768,337 41	306,000 00
CIVIL ESTABLISHMENT.			
Navy-yard, Portsmouth, N. H.:			
One clerk to civil engineer, at $1,400 per annum (submitted)	1,400 00		
One store and muster clerk, at $1,300 per annum (submitted)	1,300 00		
One writer, at $1,017.25 per annum (submitted)	1,017 25		
One mail messenger, at $2.23 per diem (submitted)	697 99		
One messenger, at $2 per diem (submitted)	626 00		
One foreman laborer, at $4 per diem (submitted)	1,252 00		
One pilot, at $3 per diem (submitted)	939 00		
		7,232 24	
Navy-yard, Boston, Mass.:			
One clerk to civil engineer, at $1,400 per annum (submitted)	1,400 00		
One store and muster clerk, at $1,300 per annum (submitted)	1,300 00		
One writer, at $1,017.25 per annum (submitted)	1,017 25		
One foreman, at $4 per diem (submitted)	1,252 00		
One mail messenger, at $2.26 per diem (submitted)	707 38		
One messenger, at $1.76 per diem (submitted)	550 88		
One messenger, at $1.76 per diem (submitted)	550 88		
One messenger, at $1.76 per diem (submitted)	550 88		
		7,329 27	

Detailed estimates of appropriations required, &c.—**Continued.**

Detailed objects of expenditure, and explanations.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropri-
CIVIL ESTABLISHMENT—continued.			
Navy-yard, Brooklyn, N. Y.:			
One clerk to civil engineer, at $1,400 per annum (submitted)	1,400 00		
One store and muster clerk, at $1,300 per annum (submitted)	1,300 00		
One writer, at $1,017.25 per annum (submitted)	1,017 25		
One writer, at $1,017.25 per annum (submitted)	1,017 25		
One general foreman, at $5 per diem (submitted)	1,565 00		
One mail messenger, at $2.50 per diem (submitted)	782 50		
One yards and docks messenger, at $2.50 per diem (submitted)	782 50		
One commandant's messenger, at $2.50 per diem (submitted)	782 50		
One captain's messenger, at $2.50 per diem (submitted)	782 50		
One bell-ringer and lamp-lighter, at $2.26 per diem (submitted)	707 38		
One foreman laborer, at $4 per diem (submitted)	1,252 00		
		11,388 88	
Navy-yard, League Island, Pa.:			
One clerk to civil engineer, at $1,400 per annum (submitted)	1,400 00		
One store clerk, at $1,300 per annum (submitted)	1,300 00		
One writer, at $1,017.25 per annum (submitted)	1,017 25		
One messenger and telegraph operator, at $3 per diem (submitted)	939 00		
One mail messenger, at $1.91 per diem (submitted)	597 83		
One messenger, at $2 per diem (submitted)	626 00		
One foreman laborer, at $4 per diem (submitted)	1,252 00		
		7,132 08	
Navy-yard, Washington, D. C.:			
One clerk to civil engineer, at $1,400 per annum (submitted)	1,400 00		
One store clerk, at $1,300 per annum (submitted)	1,300 00		
One writer to civil engineer, at $1,017.25 per annum (submitted)	1,017 25		
One messenger, at $2.74 per diem (submitted)	857 62		
One messenger, at $2 per diem (submitted)	626 00		
One messenger, at $1.76 per diem (submitted)	550 88		
One bell-ringer and lamp-lighter, at $2 per diem (submitted)	626 00		
One foreman laborer, at $4 per diem (submitted)	1,252 00		
One telegraph operator, at $1.76 per diem (submitted)	550 88		
		8,180 63	
Navy-yard, Norfolk, Va.:			
One clerk to civil engineer, at $1,400 per annum (submitted)	1,400 00		
One store and muster clerk, at $1,300 per annum (submitted)	1,300 00		
One writer, at $1,017.25 per annum (submitted)	1,017 25		
One draughtsman, at $3.50 per diem (submitted)	1,095 50		
One foreman laborer, at $4.50 per diem (submitted)	1,408 50		
Four messengers, at $2 each per diem (submitted)	2,504 00		
One pilot, at $2.26 per diem (submitted)	707 38		
		9,432 63	
Navy-yard, Pensacola, Fla.:			
One writer, at $1,017.25 per annum (submitted)	1,017 25		
One mail messenger, at $2 per diem (submitted)	626 00		
		1,643 25	
Navy-yard, Mare Island, Cal.:			
One clerk to civil engineer, at $1,400 per annum (submitted)	1,400 00		
One store and muster clerk, at $1,300 per annum (submitted)	1,300 00		
One writer, at $1,017.25 per annum (submitted)	1,017 25		
One draughtsman, at $5 per diem (submitted)	1,565 00		
One foreman mason, at $6 per diem (submitted)	1,878 00		
One quarterman brick mason, at $5 per diem (submitted)	1,565 00		

Detailed estimates of appropriations required, &c.—Continued.

...ailed objects of expenditure, and explanations.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the current fiscal year, ending June 30, 1886.
CIVIL ESTABLISHMENT—continued.			
...e quarterman stone mason, at $5 per diem (submitted)	1,565 00		
...e pilot of tug, at $4 per diem (submitted)	1,252 00		
...e mail messenger, at $2.26 per diem (submitted)	707 38		
...wo messengers, at $2.20 each per diem (submitted)	1,377 20		
...e bell-ringer, at $2.26 per diem (submitted)	707 38		
...e foreman laborer, at $5.50 per diem (submitted)	1,721 25		
		16,065 46	
...station, Sackett's Harbor, N. Y.:			
...e ship-keeper, at $1 per diem (submitted)	365 00	365 00	
		68,759 44	
...priation act March 3, 1885			24,000 00

...—The clerks and writers only have heretofore ...rovided for under appropriation "civil establish-... but in accordance with section 3 of naval appro...n act approved 30th January, 1885, the Bureau has ...d the "specific estimates for civilian employés" ...fore paid from other appropriations. See section 3, ...led:

"...3. That the Secretary of the Navy is hereby di...to report to Congress, at its next and each regular ... thereafter, the amount expended during the prior ...ear, from the appropriations for the pay of the Bureaus of Navigation, Ordnance, Equipment and ...ing, Yards and Docks, Medicine and Surgery, Pro... and Clothing, Construction and Repair, and Engineering, for civilians employed on clerical ... or any other capacity than as ordinary mechan... workingmen, and to submit under the estimates of the Navy and for the respective Bureaus enu...d above specific estimates for such civilian em... for the fiscal year eighteen hundred and eighty-... and each fiscal year thereafter.

...proved, January 30, 1885.

...cial. Navy Department, January 31, 1885."

...companying this report is an abstract of offers for supplies received ...rnishing articles coming under the cognizance of the Bureau of ...s and Docks, made in conformity to act of Congress approved March ...43.

...statement showing the amounts expended under each specific head ...propriation during the fiscal year ending June 30, 1885, and the ...ces remaining unexpended June 30, as required by section 429, ...sed Statutes.

... a report showing amount expended during the fiscal year end... June 30, 1885, from appropriations pertaining to this Bureau for ...lians employed on clerical duty or in any other capacity than as ...ary mechanics and workingmen at the several navy-yards, with ...ates for the same for the fiscal year ending 30th June, 1887, in com...ce with the third section of naval appropriations act approved ...ary 30, 1885."

I am, very respectfully, your obedient servant,

D. B. HARMONY,
Chief of Bureau.

W. C. WHITNEY,
Secretary of the Navy,
Navy Department, Washington, D. C.

Report showing amount expended during the fiscal year ending June 30, 1885, from app ations pertaining to the Bureau of Yards and Docks for civilians employed on clerica or in any other capacity than as ordinary mechanics and workingmen, at the several yards, and submitting estimates for such civilian employés for the fiscal year 1887, w pliance with the third section of naval appropriation act approved January 30, 1885.

Navy-yards, and rating and rate of pay	Amount paid to civilian employés during fiscal year ending June 30, 1885.	Estimates for c employés fo fiscal year June 30, 1887.	
		Rate of pay.	Am
NAVY-YARD, PORTSMOUTH, N. H.			
Clerk to civil engineer, at $1,400 per annum	$1,400 00	$1,400 00	$1
Store and muster clerk, at $1,300 per annum	1,300 00	1,300 00	1
Writer, at $1,017.25 per annum	801 69	1,017 25	1
Writer, at $3 per diem	729 00	....	..
Mail messenger at $2 23 per diem	640 01	2 23	
Messenger, at $2 per diem	426 00	2 00	
Foreman laborer, at $4 per diem	1,092 00	4 00	1
Pilot, at $3 per diem	825 00	3 00	
	7,213 70		7
NAVY-YARD, BOSTON, MASS.			
Clerk to civil engineer, at $1,400 per annum	1,400 00	1,400 00	1
Store and muster clerk, at $1,300 per annum	1,300 00	1,300 00	1
Writer, at $3.26 per diem	1,015 49	*1,017 25	1
General foreman, at $5 per diem	1,092 00	....	......
Foreman laborer, at $4.50 and $4 per diem	1,238 75	4 00	1
Mail messenger, at $2.26 per diem	824 90	2 26	
Messenger, at $1 76 per diem	513 50	1 76	
Messenger, at $1.76 per diem	513 04	1 76	
Messenger, at $1.76 per diem	508 36	1 76	
	8,401 04		7
NAVY-YARD, BROOKLYN, N. Y.			
Clerk to civil engineer, at $1,400 per annum	1,330 82	1,400 00	1
Store and muster clerk, at $1,300 per annum	1,300 00	1,300 00	1.
Writer, at $1,017 25 per annum	1,011 68	1,017 25	1.
Writer, at $1,017 25 per annum	1,017 16	1,017 25	1,
Draughtsman, at $5 per diem	1,185 00	....	......
General foreman, at $5 per diem	1,185 00	5 00	1,
Mail messenger, at $2 50 per diem	890 42	2 50	
Yards and docks messenger, at $2 50 per diem	728 04	2 50	
Commandant's messenger, at $2.50 per diem	761 78	2 50	
Captain's messenger, at $2.50 per diem	665 74	2 50	
Bell-ringer, at $2 26 per diem	816 99	2 26	
Foreman laborer, at $4 and $4.50 per diem	1,322 00	4 00	1,
	12,296 23		11,
NAVY-YARD, LEAGUE ISLAND, PA.			
Clerk to civil engineer, at $1,400 per annum	1,400 00	1,400 00	1,
Writer at $1 017 25 per annum	1,017 25	1,017 25	1,
Messenger and telegraph operator, at $3 per diem	819 00	3 00	
Mail messenger, at $1 91 per diem	655 88	1 91	
Messenger, at $2 per diem	589 00	2 00	
Foreman laborer at $4 and $5 per diem	1,354 00	4 00	1,
Store clerk, at $1 300 per annum	......	1,300 00	1,
	5,835 13		7,
NAVY-YARD WASHINGTON, D. C.			
Clerk to civil engineer, at $1,400 per annum	1,400 00	1,400 00	1,
Store clerk at $1,300 per annum	1,300 00	1,300 00	1,
Writer to civil engineer, at $3 per diem	683 75	*1,017 25	1,
Draughtsman at $4 50 per diem	356 50	....	......
Messenger at $2 74 per diem	808 73	2 74	
Messenger, at $2 and $2.33 per diem	676 37	2 00	
Messenger at $1 76 and $2 per diem	583 48	1 76	
Telegraph operator, at $1 76 per diem	154 00	1 76	
Bell ringer, at $1 76 and $2 per diem	585 04	2 00	
Foreman laborer, at $4 per diem	....	4 00	1,
	6,547 87		8,

* Per annum.

Report showinh amount expended during the fiscal year, &c.—Continued.

Navy-yards, and rating and rate of pay.	Amount paid to civilian employés during fiscal year ending June 30, 1885.	Estimates for civilian employés for the fiscal year ending June 30, 1887.	
		Rate of pay.	Amount.
NAVY-YARD, NORFOLK, VA.			
civil engineer, at $1,400 per annum	1,399 98	1,400 00	1,400 00
id muster clerk, at $1,300 per annum	1,299 95	1,300 00	1,300 00
it $1,017.25 per annum	1,015 54	1,017 25	1,017 25
sman, at $3.50 per diem	271 25	3 50	1,095 50
foreman, at $5 per diem	1,220 00	....	....
ı laborer, at $4 and $4.50 per diem	1,148 75	4 50	1,408 50
it $1.50 per diem.	284 75	....	....
er, at $2 per diem	637 00	2 00	626 00
er, at $2 per diem	618 00	2 00	626 00
;er, at $2 per diem	618 00	2 00	626 00
er, at $2 per diem	616 00	2 00	626 00
$2.26 per diem	666 70	2 26	707 38
	9,790 87		9,432 63
NAVY-YARD, PENSACOLA, FLA.			
it $1,017.25 per annum	955 75	1,017 25	1,017 25
ssenger, at $2 per diem	453 00	2 00	626 00
	1,408 75		1,643 25
NAVY-YARD, MARE ISLAND, CAL.			
civil engineer, at $1,400 per annum	1,400 00	1,400 00	1,400 00
d muster clerk, at $1,300 per annum	1,171 78	1,300 00	1,300 00
it $1,017.25 per annum	1,017 25	1,017 25	1,017 25
it $3.50 per diem	834 75	....	....
and receiver, at $3.50 per diem	888 50	....	....
at $4 per diem	960 00	....	....
sman, at $5.50 per diem	1,691 25	5 00	1,565 00
sman, at $5.50 per diem	1,264 00	....	....
ı mason, at $5 and $6 per diem	1,404 00	6 00	1,878 00
nan brick mason, at $6 per diem	904 24	5 00	1,565 00
nan stone mason, at $5.50 per diem	836 24	5 00	1,565 00
ı laborer, at $5.50 per diem	1,325 25	5 50	1,721 25
;ug, at $4.80 per diem	1,365 80	4 00	1,252 00
other tugs, at $3 per diem	463 50	....	....
ssenger, at $2.74 per diem	1,000 10	2 26	707 38
er, at $2.20 per diem	509 50	2 20	688 60
er, at $2.20 per diem	190 10	2 20	688 60
r, at $2.74 per diem	669 86	2 26	707 38
	17,896 12		16,055 46
PORT ROYAL, S. C.			
sman, at $4.47 per diem	586 11		....
SACKETT'S HARBOR, N. Y.			
per, at $1 per diem	365 00	1 00	365 00

* Per annum.

ation of expenditures for civilian employés for fiscal year ending June 30, 1885, *and* *for the same for fiscal year ending June* 30, 1887; *per act approved January* 30,

Navy-yards.	Expended, 1884–'85.	Estimates, 1886–'87.
h, N. H	$7,213 70	$7,232 24
ss	8,401 04	7,329 27
N. Y	12,298 23	11,388 88
land, Pa	5,835 13	7,182 08
n, D. C.	6,547 87	8,180 63
	9,790 87	9,432 63
	1,408 75	1,643 25
al	17,896 12	16,055 46
. C.	586 11	....
rbor, N. Y	365 00	365 00
	70,342 82	68,759 44

Statement of the appropriations for the Bureau of Yards and Docks for the fiscal year ending June 30, 1885, showing the amounts expended under each specific head of appropriation, and the balances remaining unexpended June 30, as required by section 429, Revised Statutes.

Appropriation for "general maintenance"	$200,000 00
Expended from July 1, 1884, to June 30, 1885	192,
Balance on hand July 1, 1885	7,019

Outstanding obligations for gas, water, advertising, &c., will absorb nearly all of the above balance of appropriation.

Appropriation for "repairs and preservation"	$125,
Expended from July 1, 1884, to June 30, 1885	121,
Balance on hand July 1, 1885	3,

Which will be absorbed when outstanding liabilities for materials are paid.

Appropriation for "civil establishment"	$24,000
Expended from July 1, 1884, to June 30, 1885	23,
Balance on hand July 1, 1885	216 21

Which balance will revert to the Treasury.

Appropriation for navy-yard, Brooklyn, N. Y.: "Dredging"	[illegible]
Expended from July 1, 1884, to June 30, 1885	[illegible]
Appropriation for navy-yard, Brooklyn, N. Y.: "Cob dock"	47,362 00
Expended from July 1, 1884, to June 30, 1885	2,133 03
Balance on hand July 1, 1885	45,228 97

Payment under contract for crib-work and piling will absorb the entire balance.

Appropriation for navy-yard, Mare Island, Cal.: "Stone dry-dock"	[illegible]
Expended from July 1, 1884, to June 30, 1885	[illegible]
Balance on hand July 1, 1885	63,858

Contract for pumping machinery and other outstanding liabilities will absorb the entire balance of this appropriation.

Appropriation for contingent	$15,000
Expended from July 1, 1884, to June 30, 1885	12,546
Balance on hand July 1, 1885	2,453

Nearly all of which will revert to the Treasury.

Appropriation for Naval Asylum, Philadelphia	$59,813
Expended from July 1, 1884, to June 30, 1885	46,054
Balance on hand July 1, 1885	13,758 5

After outstanding liabilities are paid about $3,000 of the above balance of appropriation will revert to the Treasury.

ABSTRACT OF OFFERS RECEIVED FOR FURNISHING SUPPLIES COMING UNDER THE COGNIZANCE OF THE BUREAU OF YARDS AND DOCKS MADE IN CONFORMITY TO THE ACT OF CONGRESS, MARCH 3, 1843, FOR FISCAL YEAR ENDING JUNE 30, 1885.

Scale of offers for supplies for navy-yard at Portsmouth, N. H., under advertisement of J 11, 1884.

Corn-meal and oats:	
William A. Plaisted	*[illegible]
Hay:	
C. H. Bartlett	[illegible]
E. J. Wilson	[illegible]
C. W. Cottle & Son	475
S. W. Junkins	392
Timothy Furbish	419

* Awarded.

Bituminous coal:	
J. Albert Walker	*$1,071 60
E. F. Sise & Co	1,190 04
Anthracite coal:	
J. A. Walker	*775 15

Scale of offers for supplies for navy-yard at Portsmouth, N. H., under advertisement of July 21, 1884.

Stationery:	
Mercer Goodrich	$69 05
H. B. Buzzell & Son	*68 63
Lumber:	
John H. Broughton	*148 00
T. E. Call & Son	185 50
Linseed oil:	
Rider & Cotton	*26 55
William Winslow	28 35
W. J. Sampson & Co	26 55
Paints, oils, &c.:	
Rider & Cotton	89 23
W. J. Sampson & Co	*82 64
Iron pipe, coupling, &c.:	
Rider & Cotton	*56 75
Miscellaneous, requisition No. 3:	
Rider & Cotton	*40 45
Miscellaneous, requisition No. 4:	
Rider & Cotton	*276 01

Scale of offers for supplies for navy-yard at Portsmouth, N. H., under advertisement of July 25, 1884.

Twenty-five tons hay:	
S. W. Junkin	*$374 75
Timothy Furbish	448 00
Provender:	
William A. Plaisted	*240 00
J. Brooks & Co	244 65

Scale of offers for supplies for navy-yard, at Portsmouth, N. H., under advertisement of August 27, 1884.

Stationery:	
Mercer Goodrich	*$73 80
H. B. Buzzell & Son	109 55

Scale of offers for supplies for navy-yard at Portsmouth, N. H., under advertisement of September 8, 1884.

Fifteen hundred gallons gas oil:	
Rider & Cotton	*$148 50
W. A. Wood & Co	150 00

Schedule of offers for supplies for navy-yard at Portsmouth, N. H., under advertisement of December 5, 1884.

Gas oil, requisition 28.	
Rider & Cotton	*$99 00
George Dunbar & Co	115 00
Gas-pipe, &c., requisition 29:	
Rider & Cotton	*44 72
George Dunbar & Co	58 98
Window-shades, requisition 30:	
Mercer Goodrich	*25 00
George Dunbar & Co	29 25
Rider & Cotton	29 25

Schedule of offers for supplies for navy-yard at Portsmouth, N. H., under advertisement of December 11, 1884.

[illegible]pet, requisition 32:	
[illegible] Locke	*$71 92
[illegible] B. French	73 66
[illegible]. Pray, Sons & Co	74 24

* Awarded.

Schedule of offers for supplies for navy-yard at Portsmouth, N. H., under advertisement of January 23, 1885.

Meal and oats:	
J. Brooks & Co	*$206
W. A. Plaisted	213
Hay:	
J. D. Plaisted	
T. Furbish	41[illegible]
P. M. Langton	418

Schedule of offers for supplies for navy-yard at Portsmouth, N. H., under advertisement of February 3, 1885.

Lanterns:	
Rider & Cotton	
White lead, &c.:	
Rider & Cotton	*98
A. P. Wendell & Co	
Hardware:	
Rider & Cotton	*58 24
A. P. Wendell & Co	69 13
Coal:	
J. A. Walker	*1,810 30
E. F. Sise & Co	2,855 75
Stationery, requisition 37:	
Mercer Goodrich	*107
H. B. Buzzell & Son	12[illegible] [illegible]
Stationery, requisition 38:	
H. B. Buzzell & Son	*32
Mercer Goodrich	35 00
Stationery, requisition 39:	
H. B. Buzzell & Son	*81 61
Mercer Goodrich	84 50
Stoves:	
J. P. Sweetzer	*114
Lumber:	
J. E. Call & Son	*128 00
G. A. Hammond	157

Schedule of offers for supplies for navy-yard at Portsmouth, N. H., under advertisement of February 16, 1885.

Pig-iron and gas oil:	
Rider & Cotton	*[illegible]

Schedule of offers for supplies for navy-yard at Portsmouth, N. H., under advertisement of March 10, 1885.

Lumber:	
John H. Broughton	*$23
T. E. Call & Son	24 —
G. A. Hammond	30
Alcohol:	
Rider & Cotton	*13 50
Twenty-five brass tubes:	
Rider & Cotton	*74 88
Hardware:	
Prior & Mathews	*96 05
Rider & Cotton	102 42

Schedule of offers for supplies for navy-yard at Portsmouth, N. H., under advertisement of March 20, 1885.

Galvanized iron pipe:	
Rider & Cotton	*$420 47
John P. Sweetzer	454 88

* Awarded.

hedule of offers for supplies for navy-yard at Portsmouth, N. H., under advertisement of April 11, 1885.

orse-collars, brooms, &c.:
Rider & Cotton *$30 15
ment and cement pipe:
John A. Broughton *161 75
Dennis Shea 163 75
pipe:
Rider & Cotton *85 30
John P. Sweetser 87 48

edule of offers for supplies for navy-yard at Portsmouth, N. H., under advertisement of May 11, 1885.

ifteen tons hay:
E. C. Spinney *$284 25
Ervin & Wilson 292 35
George L. Moulton 285 60
rn-meal and oats:
William A. Plaisted *137 20
J. Brooks & Co 141 60
ne 16-foot flag:
George T. Vaughn & Co 13 65
T. S. Gay 12 50
Rider & Cotton *10 50

hedule of offers for supplies for navy-yard at Portsmouth, N. H., under advertisement of June 3, 1885.

Four barrels cement:
John H. Broughton *$5 00
J. Albert Walker 6 40
s, screws, &c.:
John P. Sweetser *19 70
Rider & Cotton 27 00

hedule of offers for supplies for navy-yard at Boston, Mass., under advertisement of July 22, 1884.

Broken and stove coal:
C. A. Campbell *$1,588 70
Provender:
John Mullett *925 00
Nathan Tufts & Son 934 00

dule of offers for supplies for navy-yard at Boston, Mass., under advertisement of September 5, 1884.

ionery:
J. L. Fairbank & Co *$101 25
me:
N. Tufts & Son *13 80
G. D. Putnam & Co 13 80
s:
..mes & Abbott *224 00

G. D. Putnam & Co *12 25

of offers for supplies for navy-yard at Boston, Mass., under advertisement of September 15, 1884.

nery:
J. L. Fairbanks & Co *$136 25

of offers for supplies for navy-yard at Boston, Mass., under advertisement of December 16, 1884.

er:
n Mullett *$1,095 00

* Awarded.

Scale of offers for supplies for navy-yard at Boston, Mass., under advertisement of February 5, 1885.

Four hundred and thirty tons coal:	
J. A. Wellington & Co	*$2,[illegible]
C. A. Campbell	2,[illegible]

Scale of offers for supplies for naval station at New London, Conn., under advertisement of August 2, 1884.

Provender:	
Arnold Rudd	$79 20
Smith & Caulkins	*77 85
James Greenfield	91 80

Scale of offers for supplies for naval station at New London, Conn., requisition No. 4.

Provender:	
Smith & Caulkins	*$174 85
Signal oil:	
C. A. Weaver & Co	*10 00

Scale of offers for supplies for navy-yard at Brooklyn, N. Y., under advertisement dated July 28, 1884.

Coal:	
C. H. Bass	$1,538 20
S. G. French	1,543 15
A. P. Brown	*1,496 40
D. Babcock & Co	1,643 65
C. H. Raymond	1,616 20
Provender:	
George W. Child	1,244 08
E. R. Shipman	*1,243 42
Stationery, lot 1:	
George W. Pertain	39 91
Arthur & Bonnell	40 35
W. A. Wheeler & Co	43 10
Callahan & Gartland	*35 65
Collins & Sesnon	50 84
James R. Michael	100 00
Stationery, lot 2:	
George W. Pertain	86 12
Arthur & Bonnell	96 35
W. A. Wheeler & Co	108 75
Callahan & Gartland	*68 35
Collins & Sesnon	85 03
James R. Michael	120 00
Stationery, lot 3:	
George W. Pertain	68 94
Arthur & Bonnell	67 50
W. A. Wheeler & Co	79 95
Callahan & Gartland	58 40
Collins & Sesnon	*41 90

Scale of offers for supplies for navy-yard at Brooklyn, N. Y., under advertisement of August 11, 1884.

Spikes, cement, and slate:	
D. Babcock & Co	*$266 25

Scale of offers for supplies for navy-yard at Brooklyn, N. Y., under advertisement of September 11, 1884.

Miscellaneous:	
Austin P. Brown	*$105 75
D. Babcock & Co	139 25
Drain-pipe:	
D. Babcock & Co	*89 00
Austin P. Brown	165 00

* Awarded.

hedule of offers for dredging at navy-yard at Brooklyn, N. Y., under advertisement of September 15, 1884.

redging (per cubic yard, measured in scows):	
Atlantic Dredging Company (per R. G. Packard, president)	$0 33
Moore & Wright	28
Elijah Brainard	30
Morris & Cumming Dredging Company	24$\frac{1}{2}$
Henry Dubois & Sons	18$\frac{3}{8}$
W. H. Beard	*16
William Harrigan	†14$\frac{1}{8}$

ale of offers for supplies for navy-yard at Brooklyn, N. Y., under advertisement of January 14, 1885.

rovender:	
E. R. Shipman	*$154 24

ale of offers for supplies for navy-yard at Brooklyn, N. Y., under advertisement of February 7, 1885.

al scuttles:	
D. Babcock & Co	*$7 25
orse blankets:	
D. Babcock & Co	‡179 10
ationery:	
Arthur & Bonnell	143 17
Callahan & Gartland	*142 00
Collins & Sesnon	155 64
G. W. Pertain	189 50
al:	
D. Babcock & Co	1,570 25
C. H. Bass	1,337 65
C. H. Raymond	*1,324 15
S. G. French	1,412 90
Wynant & Terhune	1,448 40
rovender:	
E. R. Shipman	*1,351 00

ale of offers for supplies for navy-yard at Brooklyn, N. Y., under advertisement of February 27, 1885.

iscellaneous articles:	
D. Babcock & Co., requisition No. 55	*$77 90
D. Babcock & Co., requisition No. 57	*53 62
D. Babcock & Co., requisition No. 60	*184 75
D. Babcock & Co., requisition No. 61	*325 65
Austin P. Brown, requisition No. 62	*337 96
D. Babcock & Co., requisition No. 62	350 85
D. Babcock & Co., requisition No. 63	*36 06

ale of offers for supplies for navy-yard at Brooklyn, N. Y., under advertisement of April 14, 1885.

al:	
C. H. Bass	*$378 00
C. H. Raymond	380 00
D. Babcock & Co	384 00

Scale of offers for supplies for navy-yard at Brooklyn, proposals invited April 21, 1885.

wer connections:	
James Armstrong	*$288 11
Lewis & Patterson	439 00

Scale of offers for supplies for navy-yard at Brooklyn, N. Y., on requisition No. 86.

wer pipes, &c., for stable:	
F. A. Hutchinson	*$185 00
E. A. Milne	242 00
James Armstrong	294 00

*Awarded. †Withdrawn. ‡Not awarded; price excessive.

Scale of offers for supplies for navy-yard at Brooklyn, N. Y., under advertisement of May 1, 1885.

Crib-work and sheet-piling:	
John F. Dawson	$62,593 54
J. E. White	65,900 00
Joseph Walsh	48,000 00
James D. Learey	57,390 00
Flaherty & O'Connell	*47,574 28
William P. Kelly	52,645 20
P. Sanford Ross	64,890 00

Scale of offers for supplies for navy-yard at League Island, Pa., under advertisement dated July 18, 1884.

Stationery:	
Magee Printing House	*$177 82

Scale of offers for supplies for navy-yard at League Island, Pa., under advertisement of July 25, 1884.

Provender:	
Paul J. Field	$416 75
R. McKnight & Sons	*414 05
Coal:	
John Street, jr	*213 75
Patrick & Lipsett	272 95

Scale of offers for supplies for navy-yard at League Island, Pa., under advertisement dated February 7, 1885.

Astral oil:	
Darrah & Elwell	*$39 75
John Jones	40 50
C. J. Field	42 00
Horseshoes, nails, &c.:	
Darrah & Elwell	44 65
Paul J. Field	47 26
C. J. Field	*36 60
Ice:	
Knickerbocker Ice Company per 100 pounds	*40

Scale of offers for supplies for navy-yard at League Island, Pa., under advertisement of February 12, 1885.

Stationery, requisition No. 26:	
Magee Printing House	$64 90
John Wanamaker	*49 85
Stationery, requisition 27:	
Magee Printing House	*82 90
John Wanamaker	†77 90
Stationery, requisition 28:	
Magee Printing House	*6 97
John Wanamaker	†3 62
Oil lamps, &c.:	
Paul J. Field	*158 36
Charles J. Field	165 74
Coal:	
John Street, jr	*304 25
H. C. Cook	357 50
Provender:	
Paul J. Field	*313 96
R. McKnight & Son	371 25

Schedule of offers for supplies for Naval Asylum, Philadelphia, under advertisement dated December 8, 1884.

Stationery:	
Magee Printing House	*$116 80
Miscellaneous articles, requisition 19:	
Charles J. Field	*100 81
Miscellaneous articles, requisition 20:	
Charles J. Field	*23 08

* Awarded. † Incomplete.

dule of offers for supplies for Naval Asylum, Philadelphia, under advertisement of February 26, 1885.

ating mattresses and pillows:	
John M. J. German	$210 24
J. W. Eagan & Co	160 92
William T. Bernstein & Co	124 44
V. Paulin	240 00
L. Adler	289 20
Dell Noblit & Co	*113 40
Amos Hilborn & Co	156 00
William McArthur & Co	356 40
John Wanamaker	157 20

dule of offers for supplies for Naval Asylum, Philadelphia, under advertisement dated March 7, 1885.

aying hearths:	
Thomas A. Lynch	$88 17
Rand & Harmer	149 00
John Williams	90 00
E. H. Benedict & Co	175 00
William H. Dennis	75 00
William Chestnut	*49 00
Thomas Gannon	99 00
F. B. Van Horn	40 00
P. F. Donnelly	100 00
John & Hunter	148 00
ering:	
J. F. Stewart & Co	114 00
S. R. Dubbs & Co	120 00
E. Thompson	*114 00
E. H. Benedict & Co	120 00
James McConnell	120 00
atting in water-closets:	
McEwen & Magee	592 00
W. H. Green	600 00
Thomas Brown	583 24
McGuckin & Gill	634 00
D. D. Mullin	650 00
W. B. Dexey	490 00
William McCormick	550 00
R. E. Henderson	500 00
Rand & Harmer	*489 00
L. O. Howell, jr	583 00
ointing wall:	
Thomas Gannon	879 00
S. B. Davis & Sons	†140 00
F. B. Van Horn	315 00
T. A. Lynch	481 55
S. Dubbs & Co	*275 00
Rand & Harmer	670 00
John Williams	375 00
W. H. Dennis	300 00
William Chestnut	395 00
E. H. Benedict & Co	622 00
Johns & Hunter	550 00
P. F. Donnelly	345 00
aking harness:	
D. Forrest	*68 75
John Hunter	80 00
W. H. Brady	100 00
ebuilding laundry furnace:	
Thomas Gannon	†18 00
F. B. Van Horn	59 00
P. F. Donnelly	40 00
T. A. Lynch	41 51

* Awarded. † Irregular.

Rebuilding laundry furnace:	
Johns & Hunter	$70 00
Rand & Harmer	38 00
John Williams	55 00
William Chestnut	*29 00
Repairing bedsteads:	
William F. Bernstein & Co	48 50
C. B. Newhauser	50 00
F. Iles	59 00
Scott & Hutchinson	*45 00
Strawbridge & Chase	49 50
Making ash-cart:	
C. B. Newhauser	*25 00
Scott & Hutchinson	50 00
Wilson, Childs & Co	34 00
Trees and seed:	
Henry A. Dreer	*28 75
Hand fire-grenades:	
F. Stephanie	*40 00

Schedule of offers for supplies for Naval Asylum, Philadelphia, under advertisement of April 9, 1885.

Books:	
John Wanamaker	*$91 75
J. B. Lippincott & Co	102 65
Ice:	
Knickerbocker Ice Company per ton	*4 75
Wire cloth:	
C. J. Field	14 66
E. Darby & Sons	14 67
De Witt Wire Cloth Company	14 66
J. J. Shannon	14 60
P. J. Field	*14 48

Schedule of offers for supplies for Naval Asylum, Philadelphia, under advertisement of May 11, 1885.

Cleaning up cemetery lot:	
Mt. Moriah Cemetery Company	*$62 00
Erecting tombstones:	
Dolan Bros	†78 00
E. Sprague & Co	†96 00
Bye & Carman	*72 00
Repairing chapel organ:	
John M. Kern	45 50
A. G. Ibach	20 00
Reuben Nichols	*20 00
Relaying brick pavements:	
E. J. Donnelly	165 00
Dolan Bros	395 00
J. J. Tevin	290 00
Thomas Gamon	*160 00
S. R. Dubbs	320 50
Building water-tank:	
Rand & Harmer	249 00
R. E. Henderson	*225 00
Repairing slop cart:	
Scott & Hutchinson	42 50
Newhauser Wagon Works	*27 50
Pointing walls:	
E. J. Donnelly	540 00
Dolan Bros	628 00
J. J. Tevin	500 00
S. R. Dubbs	610 00
E. H. Benedict	*500 00

*Awarded. †Irregular.

pairing roofs, &c.:		
Charles Donaghy		*$115 00
James Donnell		200 00
W. H. Townsend		160 00
Kelly & Ottenger		265 00
ying flagging:		
Dolan Bros	per linear foot	99
John Maxwell's Sons		*90
J. J. Tevin		95[illegible]
J. H. Comber		1 08
S. R. Dubbs		1 23$\frac{12}{100}$
coa matting, carpets, &c.:		
J. & J. Dobson		*368 82
John Wanamaker		410 72

hedule of offers for supplies for Naval Asylum, Philadelphia, under advertisement of May 18, 1885.

thing:	
Jacob Reed's Sons	*$6,585 00
John Wanamaker	6,647 00
ots and shoes:	
William McKnight	*2,484 00
John Wanamaker	2,580 00
rovisions:	
Albert Seigel	*9,661 25
Daniel R. Paul	13,914 50
Thomas Bradley	10,120 56
roceries:	
Robert McKeown	*10,698 50
ds:	
. S. Miller	*1,232 15
John Wanamaker	1,530 16
read:	
Gustav Menzel	2,180 00
Andrew Marshall	2,200 00
Philadelphia Home-made Bread Company	*2,100 00
bacco:	
J. Rinaldo Sank & Co	*992 00
M. A. Retten & Co	1,024 00
al and wood:	
John Street, jr	*2,554 50
H. C. Cooke	2,672 50
C. B. Norton & Co	†2,549 25
Frank K. Ward	2,655 05
ints, oils, and glass:	
Wetherill Bros	†106 25
J. J. Shannon	*262 33
Louis M. Bean & Co	†284 22
e:	
Knickerbocker Ice Company	*285 00
mber:	
Elias Pohl	*510 00
J. W. Gaskill & Sons	545 10
ovender:	
Paul J. Field	*337 10
R. McKnight & Sons	372 50
iscellaneous:	
J. J. Shannon	*740 72
Paul J. Field	951 91
ardware:	
Samuel Goodall	*281 58
Paul J. Field	286 59
J. J. Shannon	281 69

* Accepted. † Informal.

Schedule of offers for supplies for navy-yard at Washington, D. C., under advertisement of July 19, 1884.

Five hundred tons Cumberland coal:	
A. J. Harper	$1,295 00
Johnson Bros	1,500 00
Clark & Given	1,275 00
A. P. Brown	1,285 00
M. R. S. B. and Coal Company	1,785 00
Stationery:	
V. G. Fischer	*218 17
W. Ballantyne & Son	231 72
Provender:	
R. C. Hewett	*795 00
W. S. Hoge	839 25
W. M. Galt & Co	815 62

Schedule of offers for supplies for navy-yard at Washington, D. C., under advertisement of December 4, 1884.

Paints, oils, and glass:	
Martin & Butler	*$228 65
George Ryneal, jr	252 70
D. Shanahan	240 41
Hirshberg, Hollander & Co	279 98
F. Miller	272 87
Z. D. Gilman	235 23
Gas-pipe, fixtures, &c.:	
R. Leitch & Sons	*709 30
Henry McShane & Co	819 63
R. A. Robbins	1,076 55
Hayward & Hutchinson	1,078 50

Schedule of offers for supplies for navy-yard at Washington, D. C., under advertisement of January 23, 1885.

Provender:	
W. S. Hoge	$841 50
R. C. Hewett	837 00
W. M. Galt & Co	*790 83

Schedule of offers for supplies for navy-yard at Washington, D. C., under advertisement of February 4, 1885.

Iron pipe:	
A. P. Brown	$432 84
J. B. Kendall	315 40
Robert Boyd	375 50
R. Leitch & Sons	*273 37
Barber & Ross	326 49
E. G. Wheeler	347 66
Nason Manufacturing Company	403 23
Cement, lime, &c.:	
A. P. Brown	*95 00
Carriage-robe, &c.:	
Robert Boyd	92 60
E. G. Wheeler	*63 25
Lutz & Bro	67 20
Lumber:	
A. P. Brown	922 25
G. A. Shehan	604 50
Grayson & Cain	694 00
Wheatley Bros	646 00
J. W. Duryee	855 11
Willett & Libbey	*521 00
W. W. McCollough	556 00
Paris white, &c.:	
E. G. Wheeler	†142 00
Z. D. Gilman	*145 80

* Awarded. † Withdrawn.

Hardware:	
A. P. Brown	$97 30
Robert Boyd	77 05
Barber & Ross	85 59
E. G. Wheeler	*67 79

Schedule of offers for supplies for navy-yard at Norfolk, Va., under advertisement of July 22 1884.

Terra-cotta pipe:	
George L. Neville	*$240 00
Mayer & Co	296 00
Holmes & Weaver	336 00
Akron Sewer-pipe Agency	352 00

Scale of offers for supplies for navy-yard at Norfolk, Va., under advertisement of July 26, 1884.

Stationery:	
Crump & Anderson	*$375 88
Hume & Parker	389 58
Provender:	
Evans, Burwell & Tazewell	1,373 93
A. H. Lindsay	1,401 58
J. G. Reid	*1,313 44

Schedule of offers for supplies for navy-yard at Norfolk, Va., under advertisement of August 25, 1884.

Material for stoves:	
Holmes & Weaver	*$105 83

Schedule of offers for supplies for navy-yard at Norfolk, Va., under advertisement of January 27, 1885.

Provender:	
A. H. Lindsay	$1,025 48
Ethuridge & Brooks	1,091 90
J. G. Reid	1,097 55½
Evans, Burwell & Tazewell	*954 08
Miscellaneous articles:	
A. Wrenn & Son	*82 00
G. L. Neville	106 65

Schedule of offers for supplies for navy-yard a Norfolk, Va., under advertisement of March, 4, 1885.

Glass, varnish, bricks, &c.:	
Mayer & Co	*$130 50
G. L. Neville	186 50
R. J. Neely & Co	186 75
A. Buff	†101 25

Schedule of offers for supplies for navy-yard at Norfolk, Va., under advertisement of April 28, 1885.

Charcoal:	
G. L. Neville	*$4 75
Pine lumber:	
R. J. Neely & Co	*122 22
A. H. Lindsay	189 00
A. A. McCullough	136 50
L. L. Neville	151 50
Tar, pitch, &c.:	
G. L. Neville	38 25
Mayer & Co	35 00
E. V. White & Co	*34 55
Glue, glass, &c.:	
G. L. Neville	99 50
Mayer & Co	99 70
A. Buff	97 95
E. V. White & Co	*94 95

* Awarded. † Incomplete.

Fire-brick, &c.:	
G. L. Neville	$
Mayer & Co	*
E. V. White & Co	

Schedule of offers for supplies for navy-yard at Norfolk, Va., under advertisement dated 16, 1885.

Repairs to furniture:	
H. R. Anderson & Co	*$1
J. S. Crawford	1
H. Wertheimer	1

Schedule of offers for supplies for navy-yard at Pensacola, Fla., under requisition *July* 9, 1884.

Provender:	
F. Bauer	$2
J. O'Neal	*2

Scale of offers for supplies for navy-yard at Pensacola, Fla., under advertisement of Ju 1884.

Oils, &c.:	
J. O'Neal	$1
McKensie, Oerting & Co	*1

Schedule of offers for supplies for navy-yard at Pensacola, Fla., under advertisement *July* 29, 1884.

Ice:	
Pensacola Ice Company, 1,120 pounds, at 3 cents	*$
Varnish:	
J. O'Neal	
McKensie, Oerting & Co	*
Provender:	
J. O'Neal	*2
McKenzie, Oerting & Co	2
Turpentine:	
J. O'Neal	
McKensie, Oerting & Co	*
Coal:	
J. O'Neal	*
McKensie, Oerting & Co	

Schedule of offers for supplies for navy-yard at Pensacola, Fla., under advertisement of *ary* 14, 1885.

Provender:	
J. O'Neal	*$4

Schedule of offers for supplies for navy-yard at Pensacola, Fla., under advertisement *ruary* 16, 1885.

White lead, oils, &c.:	
J. O'Neal	*$4
McKensie, Oerting & Co	4

Schedule of offers for supplies for navy-yard at Mare Island, Cal., under advertisement *July* 23, 1884.

Granite, requisition No. 1:	
James McCudden	*$2,7
G. Griffith	2,7
Ice:	
Henry Connelly	*1
Stationery:	
Cunningham, Curtis & Welch	1
Dutton & Patridge	*1

* Awarded.

Granite, requisition No. 5:	
James McCudden	*$28,347 00
G. Griffith	28,862 40
John Taylor	29,377 80
Granite, requisition No. 6:	
James McCudden	*23,500 00
John Taylor	27,500 00
G. Griffith	24,000 00
Wellington coal and charcoal:	
A. Powell	*1,230 00
James McCudden	1,235 00
William Walker	1,290 00
Drawing materials:	
Cunnington, Curtis & Welch	*126 64
Coal:	
James McCudden	*6,776 25
A. Powell	6,860 00
William Walker	7,075 00
Lumber:	
A. Powell	*1,497 50
James McCudden	1,520 00
J. P. Sheldon	1,540 00
William Walker	1,622 50

[Sche]dule of offers for supplies for navy-yard at Mare Island, Cal., under advertisement of August 4, 1884.

One hundred tons cement:	
Scofield & Tevis	$1,950 00
A. Powell	1,825 00
Holmes Lime Company	2,032 05
Richards & Harrison	1,837 00
James McCudden	*1,790 00
Harness:	
H. N. Cook	*213 20
Sieves:	
D. Rutherford & Co	51 00
T. H. Selby & Co	*49 50
Lead, oil, &c.:	
Sullivan & Ravels	†511 33
D. Rutherford	585 90
Coffin & Hendry	581 40
James Gallup & Co	515 24
Whittier & Fuller	*481 81
Rope:	
D. Rutherford	1,184 16
Coffin & Hendry	1,147 15
A. Powell	1,147 15
T. H. Selby & Co	1,128 65
James Gallup & Co	*1,119 40
Rasps, &c.:	
D. Rutherford & Co	177 27
T. H. Selby & Co	*167 28
Picks, &c.:	
Coffin & Hendry	*328 50
James Gallup & Co	330 00
D. Rutherford & Co	363 00
Lumber, requisition 31:	
James McCudden	440 00
J. P. Sheldon	500 00
A. Powell	*435 00
Lumber, requisition 32:	
James McCudden	270 00
J. P. Sheldon	276 25
A. Powell	*265 00

*Accepted. †Irregular.

Scale of offers for supplies for navy-yard at Mare Island, Cal., under advertisement [illegible] August 12, 1884.

Oregon pine:	
A. Powell	$27[illegible]
James McCudden	*27[illegible]
Turner, Kennedy & Shaw	28[illegible]
Iron, steel, tubes, &c.:	
George W. Gibbs & Co	1,594 [illegible]
T. H. Shelby & Co	*1,51[illegible]
Lumber:	
Turner, Kennedy & Shaw	[illegible]
A. Powell	[illegible]
James McCudden	[illegible]
Leather:	
H. N. Cook	*29 [illegible]
Sand:	
A. Powell	1,[illegible]
James McCudden	1,[illegible]
Aden Bros	*1,[illegible]

Schedule of offers for supplies for navy-yard at Mare Island, Cal., under advertisement of August 13, 1884.

Fifty tons Wellington coal:	
James McCudden	*$595 00
A. Powell	600 00
William Walker	612 50

Schedule of offers for supplies for navy-yard at Mare Island, Cal., under advertisement of September 1, 1884.

One hundred tons Portland cement:	
James McCudden	*$1,[illegible]
Richards, Harrison & Sherwood	1,[illegible]
A. Powell	1,[illegible]

Schedule of offers for supplies for navy-yard at Mare Island, under advertisement dated September 13, 1884.

Five hundred redwood ties:	
James McCudden	$130 00
A. Powell	*120 00
Fifty-five tons hay:	
James McCudden	*935 00
A. Powell	990 00
Aden Bros	990 00

Schedule of offers for supplies for navy-yard at Mare Island, Cal., under advertisement of September 18, 1884.

Brick, cement, lime, &c.:	
James McCudden	*$388 22
A. Powell	396 22
Window-glass, oil, and lead:	
Whittier, Fuller & Co	*10 95
Hardware:	
Dunham, Carrigan & Co	*11 70

Schedule of offers for supplies for navy-yard at Mare Island, Cal., under advertisement of September 30, 1884.

Oregon pine and piles:	
James McCudden	*$4,846 56
A. Powell	4,963 56
J. P. Sheldon	5,080 56
Renton, Holmes & Co	5,081 56
Turner, Kennedy & Shaw	5,100 00
Iron and steel:	
T. H. Shelby & Co	*284 35
Shovels and glue:	
James Gallup & Co	*37 50

*Awarded.

[illegible] of offers for supplies for navy-yard at Mare Island, Cal., under advertisement of October 6, 1884.

[illegible] and sheet-zinc:	
[illegible] Selby & Co	*$218 25
W. W. Montague & Co	222 49

[illegible] of offers for supplies for navy-yard at Mare Island, Cal., under advertisement of November 6, 1884.

Oregon pine plank:	
A. Powell	*$382 20
James McCudden	389 55
Turner, Kennedy & Shaw	390 00
John P. Sheldon	395 00
[illegible] nails, &c.:	
[illegible] Gallup & Co	*54 01
[illegible]am, Carrigan & Co	58 10
D. Rutherford	61 10

[illegible] of offers of supplies for navy-yard at Mare Island, Cal., under advertisement of November 7, 1884.

One hundred tons Portland cement:	
James McCudden	*$2,249 00
A. Powell	2,260 00
D. Rutherford & Co	2,275 00

[illegible] of offers for supplies for navy-yard at Mare Island, Cal., under advertisement of November 14, 1884.

[illegible]	*$1,000 00
A. Powell	1,250 00
James McCudden	1,450 00

[illegible] of offers for supplies for navy-yard at Mare Island, Cal., under advertisement of December 6, 1884.

Fresh-water sand:	
Aden Bros	*$130 00
James McCudden	146 25
Iron pipe, rivets, and sheet-iron:	
Dunham, Carrigan & Co	127 90
George W. Gibbs & Co	*121 45
T. H. Selby & Co	127 72

[illegible]dule of offers for supplies for navy-yard at Mare Island, Cal., under advertisement dated December 9, 1884.

Lard and oil:	
Whittier, Fuller & Co	*$45 00
Miscellaneous articles:	
James Gallup & Co	*85 82
Dunham, Carrigan & Co	92 13

Schedule of offers for supplies for navy-yard at Mare Island, Cal., under advertisement of January 3, 1885.

[illegible]and cement:	
James McCudden	*$1,115 00
J. C. Merrill & Co	†1,042 50
A. Powell	1,175 00

[illegible]dule of offers for supplies for navy-yard at Mare Island, Cal., under advertisement of February 7, 1885.

[illegible] of copper:	
[illegible] Mark & Co	*$30 00
[illegible]ge:	
James McCudden	*533 00
James Brownlie	562 50
A. Powell	625 00
Rider, Somers & Co	584 00

* Awarded. † Irregular.

Schedule of offers for supplies for navy-yard at Mare Island, Cal., under advertisement February 12, 1885.

Stationery:	
Cunningham, Curtis & Welch	$297
Dutton & Patridge	*292

Schedule of offers for supplies for navy-yard at Mare Island, Cal., under advertisement March 9, 1885.

Lumber, requisition No. 67:	
John P. Sheldon	*$115 8
Turner, Kennedy & Shaw	117
Reuton, Holmes & Co	119
William Walker	117 00
A. Powell	121 50
James McCudden	117 00
Lumber, requisition 68:	
John P. Sheldon	*167 3
Turner, Kennedy & Shaw	169 0
Reuton, Holmes & Co	172
William Walker	169
A. Powell	175
James McCudden	1
Lumber, requisition 69:	
John P. Sheldon	*45
Turner, Kennedy & Shaw	46
Reuton, Holmes & Co	47
William Walker	56
A. Powell	45
James McCudden	45

Schedule of offers for supplies for navy-yard at Mare Island, Cal., under advertisement March 19, 1885.

Three thousand pounds ice:	
Henry Connolly	*$90

Schedule of offers for supplies for naval station at Key West, Fla., under advertisement February 14, 1885.

Illuminating oil:	
W. H. Monsalvage & Co	$15
W. D. Cash	*12

Schedule of offers for supplies for naval station at Port Royal, S. C., under advertisement November 1, 1884.

Materials for fence:	
N. Christenson	
McLeod & Bro	

Scale of proposals for wharf at Port Royal, S. C., under advertisement dated January 1885.

Building wharf:	
William F. Bowe. Time, four months; begin thirty days	$17,
P. Sanford Ross. Time, four months; begin twenty days	*14,
H. W. Crouch & Bro. Informal; no price named.	

* Awarded.

No. 7.—BUREAU OF NAVIGATION.

REPORT OF THE CHIEF OF THE BUREAU.

NAVY DEPARTMENT, BUREAU OF NAVIGATION,
Washington, October 19, 1885.

SIR: I have the honor to submit the following report of the Bureau of Navigation for the past year, together with the estimates for its support, and for the expenditures that will be necessary for the fiscal year ending June 30, 1887. Included in this report and transmitted herewith are the reports and estimates of the several offices under its control, together with the statements required by section 429 of the Revised Statutes of the United States, and by the third section of the naval appropriation act approved January 30, 1885.

NAVIGATION.

Compasses.—During the past year 172 compasses have been repaired, and 24 new ones made and tested.

A compass station for the more accurate determination of the deviation of the compass has been established in Narragansett Bay, in the vicinity of the measured mile.

It seems proper here to refer to the preamble and resolutions of the Chamber of Commerce of New York, submitted to the Department in January last, pointing out the desirability of establishing a compass station near that city, by quoting extracts from a letter prepared in this Bureau for the information of the Secretary, as follows:

The importance to be attached to these resolutions cannot be overestimated. As every vessel of iron or steel may be stated to be a magnet of irregular shape which causes the deviations of the compass, all iron and steel vessels built for the merchant marine should be examined upon completion for the purpose of finding their magnetic poles and neutral lines. This examination would be a magnetic survey of the ship, and should be made in a dry-dock.

The primary object of such examination and survey is to determine the best location for the standard-compass, on which depends the safe navigation of the ship. Without this survey the standard-compass may often be located in a position which, though convenient and easily accessible, is the one most likely to cause shipwreck. After the standard-compass has been located the ship should be swung at a compass station for a table of deviations, her heeling error should be found, and her steering-compass compensated if required.

All of this work should be performed by naval officers, and the only expense to the owners would be that incurred in docking and that of the time lost at the compass station. These expenses are insignificant when compared with the cost of ship and cargo, and owners should be required by law to take these measures for the protection of the lives of passengers. As a portion of the preamble correctly states in substance, by means of such examinations and observations the navigation of the vessel would be changed from one of great doubt to one of comparative certainty. The absence of all such observations may readily account for the number of iron vessels of our merchant navy which have been wrecked within the past two years.

Compass stations should be established in the vicinity of our large sea-ports. I have already stated that this Bureau has not sufficient money to carry out a plan of this kind, but the sum of $50,000 would be sufficient for the purpose, and I can recommend no ex-

penditure of money which should produce more substantial benefits than one of this kind, which would save money and lives.

With reference to the suggestion that the localities for the compass stations should be established and the buoys and beacons planted by the Treasury Department, I beg to state that the Navy Department should be charged with the entire subject, for the following reasons, viz:

That joint action on the part of officers, a portion of whom are under the control of one Executive Department and the remainder under another, is not likely to produce the best results;

That work of this character is properly under the control of naval officers, who now perform the duty for all naval vessels;

That, as the Navy Department has already the necessary instruments in its posses and officers familiar with the work, it will only be necessary to establish the station.

It will be easy to comply with that portion of the resolution recommending the preparation for distribution in a popular form to those interested of existing information o the causes and nature of the deviations of the compass, and specific instructions to ascertain and correct them; for the Bureau possesses this information and the want of alone prevents its publication. In addition to publishing this matter, I would that a series of popular lectures could be prepared by officers in this Bureau, for ery with practical illustrations at stated intervals, before an audience composed of cers of the merchant service and those connected with commerce. The preparation such lectures would cost nothing—no doubt a room in a public building could be obtaine for the purpose in New York—and the opportunities thus afforded for communicatio between the two services would be mutually beneficial.

The adoption of such resolutions as those herewith referred to by the New Yor Chamber of Commerce is therefore most opportune, and in conclusion I beg to s that the Chamber of Commerce be informed that the Navy Department is prepared make the necessary magnetic examinations of iron and steel ships, to adjust their c passes, and will be glad to establish compass stations in proper localities, provided can be obtained from Congress for that purpose.

The Bureau would have been unable to establish the one compa station in Narragansett Bay had it not been in possession of the buoy and the moorings required for the purpose.

The compass reports required from cruising vessels continue to carefully examined and the calculations verified or corrected. Fr these reports it is proposed eventually to prepare a new variation char The most complete sets of these observations, illustrating the deviati of the compass in vessels of the United States Navy, have been arrange for publication as a professional paper.

Professional paper No. 17, "Magnetism of iron and steel ships," ha been published and distributed among the officers of the Navy and me chant marine.

As the magnetism of steel ships is subject to great changes durin construction, observations have been taken from time to time to dete mine the magnetic character of the steel cruisers now building. Fo these ships four compensating binnacles have been made in the Wasl ington navy-yard from designs prepared in the Bureau.

Compass-testing house.—The work of erecting the compass-te house, for which there is an appropriation of $7,000, has begun. The foundations have been laid, the piers on which the instruments are t be mounted are in place, and the superstructure is being built. Th the building may be completed and provided with the necessary equi ment, an estimate for $2,000 has been submitted.

Determination of longitudes.—The results of the observations m e b naval officers for the determination of secondary meridians by u of the telegraph, in 1883–'84, have been published and dis among libraries, geographical societies, observatories, and those in ested in the subject.

The secondary meridians thus established are those of Vera C Guatemala, La Libertad, Paita, Lima, Arica, Valparaiso, and the tional observatory of the Argentine Republic at Cordoba.

l books.—In consequence of the improvement in the construction
a armament of war vessels and the consequent effect upon naval tac-
a revision of the signal books has become necessary, and officers
e engaged in making the necessary changes.

Navigation supplies.—Through the courtesy of the Light-House Board quantities of illuminating oils required for the Navy continue to be uded in the supplies contracted for by the Light-House establishnt. In consequence, naval vessels are supplied with better qualities oils and with greater economy than if independent contracts were le by this Bureau.

onometers are expensive but necessary instruments, and ships ust be supplied with them. There are now 240 chronometers in poson of the Bureau; of this number 132 have been condemned under rule adopted that thirty years should be considered the lifetime of navy chronometer. As few new chronometers have been purchased uring the past twenty years, the number available for issue will be still further reduced within the next few years.

It is proposed to purchase annually from chronometer makers in the United States, after a competitive trial of six months, a sufficient number of chronometers to replace those condemned from time to time.

The Omaha has been fitted with an incandescent electric light plant supplied by the Consolidated Electric Light Company of New York. The installation is reported to work satisfactorily. The Edison incandescent electric lights on board the Trenton continue to give satisfaction.

Additional books have been supplied to the libraries of cruising ships, id I desire to repeat the recommendation contained in the annual rerts of this Bureau for the past two years, that such professional matter is essential to naval officers and of value to the merchant marine d to the ship-building interests, be published. This cannot now be ne for want of an appropriation.

Ocean surveys.—It is proposed that the Ranger shall be employed in unding the Pacific Ocean off the coast of Lower California and Mexco, and in examining the North Pacific Ocean for the rocks and shoals hich have been reported from time to time to exist in the track of vesls bound to and from San Francisco.

The old surveys of the coast of the Spanish Main are known to contain nany errors, and as this coast is much frequented by merchant ships owned in the United States, it is proposed that the Thetis, which was transferred to the Navy for surveying purposes, shall be used to make the surveys necessary to correct them.

Upon the completion of this duty the Thetis should be sent to the outh Pacific Ocean to examine the many dangers to navigation which reported to exist in that section of the globe, and which are now own on charts, but the existence of which has, in many cases, not been proven.

Publication of war records.—The work of classifying and copying the naval records of the war for publication has been continued as rapidly as the small force at the disposal of the Bureau will allow. It e important that provision should be made at once for an adequate clerical force to carry on this work, and estimates have been submitted therefor. Every year's delay in procuring and copying the papers now n private hands adds to the probability of their loss or destruction. The measures adopted by Congress to provide for the compilation of the Army records have produced a work which is indispensable to the study of the war and a source of satisfaction to the participants on both sides. No book ever published by the Government has met with so great a

popular demand. The naval records, although not so voluminous as those of the Army, are quite as important, and the same reason exists for their publication. Without them the narrative is incomplete. They have besides an importance of their own, distinct from that of the Army records, in that they contain nearly all that is known, in actual practice, of modern naval warfare, and their consequent value to the legislative and executive branches of the Government, to the naval service, and to the community at large, as an aid in forming opinions on naval matters, cannot be overestimated.

Department library.—During the past year the library has continued to receive valuable additions by gift and by purchase, and the classification and cataloguing of the books has been nearly completed. The reduction of the annual appropriation from $2,500 to $1,000, made by the appropriation act of last year, is a serious obstacle to the improvement and growth of the library, which has been steadily in progress since 1882. There is certainly no object for which money may be expended more productive of direct benefit than the formation and maintenance of the collection of books of professional reference for the Navy Department, and the crippling of this important work cannot be compensated by a saving to the Government of $1,500. I therefore recommend that the appropriation of $2,500 should be renewed.

I would also renew the recommendations in reference to binding made in my last annual report, as follows:

> Under existing law, no binding can be done for any Department of the Government except in plain sheep or cloth. Exceptions to this rule have been made in favor of the Congressional Library and the libraries of the Department of State, the Patent Office, and the Office of the Surgeon-General of the Army. The restriction upon the character of the binding for other Department libraries is harmful to the interests of the Government by making it impossible to keep sets of volumes in a uniform binding, while the saving in expense is so small as to be wholly out of proportion to the resulting disadvantages; and it is clear that the reasons which exist for the exceptions in favor of the libraries of the Department of State, the Patent Office, and the Surgeon-General's Office apply with equal force to those of other Executive Departments.

Naval War College.—The first session of the Naval War College opened September 3, with a class of naval officers. The instruction consisted of full courses of lectures on marine international law and on military science, with lectures on the art of naval warfare, delivered by the officers connected with the college and by Rear-Admiral Ammen and Commander Taylor, United States Navy. Additional lectures on subjects bearing upon the course of study were given by General J. C. Palfrey, General George H. Gordon, and John C. Ropes, esq., who kindly volunteered their services without compensation.

In the course just ended, a successful beginning has been made of this highly important work. Owing to the short time for preparation, and to the fact that several of the special instructors whom it is intended to attach to the college have been necessarily occupied with duties to which they had previously been assigned, the course of instruction was not as complete as it is hoped ultimately to make it, but enough has been done to assure the final success of the institution. The War College, by giving officers an advanced course of instruction on subjects directly connected with the art of war, fills what has hitherto been a serious want in our system of naval education, and it can but commend itself to the earnest and hearty support of the Department and of Congress.

The report of the president of the college and the recommendations contained therein are fully approved by the Bureau.

HYDROGRAPHIC OFFICE.

T[illegible] survey of the west coast of Central America has been continued [illegible] south as the Gulf of Dulce by the officers of the Ranger during [illegible]t season. As correct charts extending from that point to Panama [illegible]e been published from recent surveys made by English naval officers [illegible] is not considered necessary to extend the survey now under the di[illegible]ion of this Bureau farther south.

[illegible] this connection I beg to state that although a specific sum was [illegible]ed for, no money was appropriated during the last session of Con[illegible] to complete the important survey of the west coast of Mexico [illegible] Central America. In consequence it is not possible to complete [illegible]e publication of charts from the surveys recently made by the officers [illegible] the Ranger.

In order that the mercantile community may have the benefit of this work as soon as practicable, an estimate has again been submitted sufficient in amount to engrave and print these charts. It is unnecessary to state that charts of this locality are very much needed.

The improvements in the construction of the charts issued by the Hydrographic Office has increased the demand for those publications. Through the agency of the branch hydrographic offices in the cities of Boston, New York, Baltimore, New Orleans, and San Francisco, nautical information contained in the archives has been distributed to the officers of the merchant marine, and in return a vast amount of additional matter has been collected for the Hydrographic Office from the observations made by these gentlemen, who have been uniformly courteous in complying with the requests of the representatives from the branch offices who have visited their ships to obtain information likely to benefit commerce in general.

I desire to invite your attention to the building in which the engraving of copper plates and the printing of charts is carried on. As it is not fire-proof, the valuable plates must be stored in the Navy Department, and carried to and from the printing room when required for use. It is impossible to remove these soft copper plates from building to building without great risk of injury.

Special conditions of light, heat, and immunity from vibrations are required by engravers and draughtsmen for the production of the best work. None of these conditions exist in the building at present occupied by the division engaged in engraving and printing charts. From the offensive odors due to the cleaning materials required in the process of printing, the work cannot be done in the State, War, and Navy Department building without great inconvenience to its occupants. To remove these obstacles to good workmanship, and the loss due to injury of plates, a building especially adapted to the purpose should be constructed as soon as possible.

I beg to repeat the statement contained in the report of the Bureau for 1884, that nautical men generally favor the adoption of a universal system of marks and buoys for channels and harbors, and to renew the suggestion for an international congress to consider and recommend one system for adoption.

NAVAL OBSERVATORY.

The report of the Superintendent of the Naval Observatory gives in detail the astronomical work performed with the various instruments during the past year, the observations of the eclipse of March 16 last, and the distribution of correct time to the principal cities and sea-ports.

Appended thereto is a report of the work done for the Transit of V Commission, relating to the observations made in 1874 and 1882.

The general adoption of the system of standard time has created a demand for more accurate time. To answer this demand and to render service to the maritime community, time-balls have been erected at Boston, Newport, the New York navy-yard, Philadelphia, Hamp Roads, Savannah, New Orleans, and San Francisco. Through the courtesy of the Western Union and Baltimore and Ohio Telegraph C nies, these time-balls are connected with and dropped from the Na O'servatory daily at noon, the temporary use of the wires being given free of charge.

Requests have been received from the maritime bodies of other cities for the time service, but it has not been possible to comply with the requests for want of an appropriation. Indeed, were it not for the free use of the telegraph lines (and voluntary labor at Savannah and Hampton Roads) the cities already mentioned could not be supplied with the cerrect time. To comply with the requests for this service an estimate is submitted herewith.

The several recommendations contained in the report relative to the observations of the solar eclipse of August 29, 1886, to permanently fixing the status of the assistant astronomers, and for the recognition of the services of the instrument maker, Mr. W. F. Gardner, in perfecting the clock system for transmitting time from the Observatory to the various Government departments, are approved by the Bureau.

I desire to renew my recommendations of last year in regard to the Naval Observatory, as follows:

The necessity for an appropriation with which to begin the buildings for the new Naval Observatory upon the site selected by a commission appointed for the purpose and purchased by the Government, so often mentioned in previous reports, is more apparent than ever in consequence of the dilapidated condition of the buildings and the unhealthy and improper location of the present Observatory, and I again urge the importance of an appropriation for that purpose.

NAUTICAL ALMANAC.

The Superintendent of the Nautical Almanac reports the progress made during the past year in preparing the annual volumes in advance, and the work performed on astronomical tables and papers.

The American Nautical Almanac for 1888 and the Ephemeris for the same year were issued in the early part of 1885, and the type work of the volume for 1889 is nearly completed. The computations for 1890 and 1891 are in course of execution. The Atlantic Coaster's Nautical Almanac for 1886 is now in press, and that for the Pacific coast was issued in September last.

ESTIMATES.

In submitting the estimates for the support of the Bureau during the coming fiscal year, I have the honor to bring to your notice the following extract from my last annual report, viz:

I beg to invite your attention to the annual appropriations for this Bureau, which have steadily decreased in amount from $192,500 for the fiscal year of 1866-'67 to $100,000 for the year 1883-'84. Since the year 1866 the amount appropriated annually to carry on the work under the cognizance of this Bureau has been insufficient to supply our vessels with the best and most improved articles of navigation outfit. In consequence, however, of the quantity of supplies purchased during the civil war, and remaining on hand at its close, cruising ships have been furnished with instruments for navigation which, if not of the latest patterns, still answer the purpose for which they were purchased in the absence of better. But the supplies above mentioned have gradually been exhausted,

ve become obsolete and have been sold as "unserviceable," in compliance with the of Congress approved August 5, 1882, which required all stores and supplies to be appraised and those found to be unserviceable to be sold.

The supply of articles of navigation outfit has still further decreased since the above was written, while the appropriation for the fiscal year ending June 30, 1885, was $87,500, a reduction of $12,500 on the amount for the previous year. The appropriation for the present fiscal year is $87,500, which is $42,500 less than the estimates.

I have submitted estimates for $130,000, an amount which in my o ion is necessary for the efficient administration of this Bureau, and out which it will not be practicable to supply our cruising vessels tn the improved outfits required for the safe navigation of modern ips of war.

Very respectfully, your obedient servant,

J. G. WALKER.
Chief of Bureau.

Hon. W. C. WHITNEY,
Secretary of the Navy.

Estimates of appropriations required for the service of the fiscal year ending June 30, 1887, by the Bureau of Navigation.

A.

FOR THE SUPPORT OF THE BUREAU OF NAVIGATION.

I.—SALARIES.

For salary of chief clerk (Revised Statutes, page 70, section 416, and act of March 3, 1885)	$1,800
For salary of one clerk of class three (act of March 3, 1885)	1,600
For salary of one clerk of class two (act of March 3, 1885)	1,400
For salary of one clerk of class two (act of March 3, 1885)	1,400
For salary of one clerk of class one (act of March 3, 1885)	1,200
For salary of one clerk (act of March 3, 1885)	1,000
For salary of one copyist (act of March 3, 1885)	900
For salary of one assistant messenger (act of March 3, 1885)	720
For salary of two laborers (act of March 3, 1885)	1,320
Total	11,340
For increase of salary of chief clerk (submitted)	450
For increase of salary of clerk of class three (submitted)	200
For increase of salary of clerk of class two (submitted)	200
For increase of salary of clerk at $1,000 (submitted)	200

B.

SALARIES, OFFICE OF NAVAL INTELLIGENCE.

For salary of one copyist (submitted)	$900
For salary of one laborer (submitted)	660

C.

I.—SALARIES, OFFICE OF NAVAL RECORDS OF THE REBELLION.

For salary of one clerk of class one (act of March 3, 1885)	$1,200
For salary of two copyists, at $720 each (act of March 3, 1885)	1,440
Total	2,640
For salary of one agent for the collection of Confederate records (submitted)	2,000
For salary of one clerk of class three (submitted)	1,600
For salary of one clerk of class two (submitted)	1,400

For salary of one clerk of class one (submitted)	$1,
For salary of two clerks, at $1,000 (submitted)	2,
For salary of two copyists, at $900 (submitted)	1,
For salary of two copyists, at $720 (submitted)	1,

II.—CONTINGENT EXPENSES.

For stationery, traveling of agent, and other contingent expenses (submitted)	1,

D.

I.—SALARIES, LIBRARY, NAVY DEPARTMENT.

For salary of one laborer (submitted)	

II.—BOOKS.

For professional books and periodicals (act of March 3, 1885)	1,
For professional books and periodicals (submitted)	1,
Total	2,

NOTE.—The amount estimated for ($2,500) is that appropriated previous to the current fiscal year. The reduced amount is totally inadequate to meet the necessities of the Department.

E.

I.—SALARIES, HYDROGRAPHIC OFFICE.

For salaries of two clerks of class two (act of March 3, 1885)	$2,
For salary of one clerk of class one (act of March 3, 1885)	1,
For salaries of draughtsmen, engravers, copyists, copper-plate printers, printers' apprentices, assistant messengers, laborers, and watchmen in the Hydrographic Office (act of March 3, 1885)	41,
Total	45,
For salary of one clerk of class four (submitted)	1,
For increase of $200, to advance one clerk of second class to class three (submitted)	
For watchman, additional engravers, and advance of others (submitted)	3

II.—CONTINGENT AND MISCELLANEOUS EXPENSES.

For purchase of chart-paper, copper-plates, electrotyping copper-plates, ink, and other materials in printing division; instruments and materials for drawing division; materials for and mounting charts; tools and materials for engravers; reduction of drawings by photography; photolithographing charts for immediate use; transfer of photolithographic and other charts to copper; repairs to printing-presses and other furniture and tools; extra drawing and engraving; translating from foreign languages in preparing charts and notices; purchase of foreign and other charts and hydrographic works for the use of vessels of the Navy and express and freight charges on the same; purchase of drawing-paper, drawing materials; surveying instruments and repairs of same to be furnished naval vessels while surveying; compiling and arranging data and printing and mailing Pilot Chart of North Atlantic Ocean, and purchase of professional works relating to hydrography, surveying and its kindred branches (act of March 3, 1885)	4
For rent of building for printing-presses, draughtsmen and engravers, storage of copper-plates and the materials used in the construction and printing of charts; gas, water, and telephone rents, and for repairs and heating of the rooms (act of March 3, 1885)	
For contingent expenses of branch offices at Boston, New York, Philadelphia, Baltimore, New Orleans, and San Francisco, including furniture, fuel, lights, rent, care of offices, messenger service in boarding ships, car-fare and ferriage in visiting merchant vessels, freight, expressage, telegrams, and other necessary expenses incurred in collecting the latest information for the Pilot Chart, and for other purposes for which the offices were established (act of March 3, 1885)	
Total	5

F.

I.—SALARIES, NAVAL OBSERVATORY.

ry of one assistant astronomer (act of March 3, 1885)	$2,000
ry of two assistant astronomers at $1,800 (act of March 3, 1885)	3,600
ry of one clerk of class four (act of March 3, 1885)	1,800
ry of one instrument-maker (act of March 3, 1885)	1,500
aries of four watchmen, including one for new Naval Observatory site f March 3, 1885)	2,880
ries of one skilled laborer at $1,000 and one skilled laborer at $720 (act rch 3, 1885)	1,720
ries of seven laborers at $660 (act of March 3, 1885)	4,620
'otal	18,120
ease to pay of one assistant astronomer (submitted)	600
ease to pay of two assistant astronomers, of $400 each (submitted)	800
ease to pay of instrument-maker (submitted)	200
ries of three computers, at $1,200 each (submitted)	3,600
ry of one copyist and indexer for library (submitted)	800

II.—CONTINGENT AND MISCELLANEOUS EXPENSES.

cellaneous computations (act of March 3, 1885)	1,200
ks, periodicals, engravings, photographs, and fixtures for the library (act rch 3, 1885)	1,000
aratus and instruments, and repairs of the same (act of March 3, 1885)	2,500
airs of buildings, fixtures, and fences, including fixtures, fences, and at new Observatory site, for fuel, furniture, gas, chemicals, stationery, t, postage, and contingent expenses (act of March 3, 1885)	3,900
ment to Smithsonian Institution for freight on Observatory publications o foreign countries (act of March 3, 1885)	136
'otal	8,736
ease of amount for repairs of buildings, fixtures, &c. (submitted)	1,100
aratus and material for experiments in solar and stellar photography itted)	1,000
ntenance of time service (submitted)	5,000
tight case for standard clock	300
feet 3-inch cotton fire-house, with necessary couplings (submitted)	600
'otal	8,000

G.

I.—NAUTICAL ALMANAC.

ries of assistants in preparing for publication the American Ephemeris autical Almanac, viz:	
ee assistants, at $1,600 (act of March 3, 1885)	$4,800
o assistants, at $1,400 (act of March 3, 1885)	2,800
ee assistants, at $1,200 (act of March 3, 1885)	3,600
o assistants, at $1,000 (act of March 3, 1885)	2,000
copyist (act of March 3, 1885)	720
assistant messenger (act of March 3, 1885)	720
laborer (act of March 3, 1885)	660
of computers on piecework in preparing for publication the American ne and Nautical Almanac, and in improving the tables of the planets f h 3, 1885)	8,400
	23,700

FOR THE NAVAL SERVICE.

I.—NAVIGATION.

For foreign and local pilotage and towage of ships of war; services and materials in correcting compasses on board ship, and for adjusting and testing compasses on shore; nautical and astronomical instruments, nautical books, maps, charts, and sailing directions, and repairs of nautical instruments for ships of war; books for libraries for ships of war; naval signals and apparatus, namely: signal lights, lanterns, rockets, running lights, drawings and engravings for signal books; compass fittings, including binnacles, tripods, and other appendages for ships' compasses; logs and other appliances for measuring the ship's way, and leads and other appliances for sounding; lanterns and lamps and their appendages for general use on board ship, including those for the cabin, ward-room, and steerage, for the holds and spirit-room, for decks and quartermasters' use; bunting and other materials for flags and making and repairing flags of all kinds; oil for ships of war other than that used in the engineer department, candles when used as a substitute for oil in binnacles and running lights, chimneys and wicks, and soap used in the navigation department; photographic instruments and materials; stationery for commanders and navigators of vessels of war, and for use of courts-martial; musical instruments and music for vessels of war; steering signals and indicators, and speaking-tubes and gongs for signal communication on board vessels of war; and for introducing and maintaining electric lights on board vessels of war (act March 3, 1885) .... $13(

NOTE.—The amount asked for ($130,000) is the same as that submitted for the current fiscal year, for which, however, only $87,500 were appropriated. It is proposed to replace by new instruments of modern construction the old chronometers, sextants, spy-glasses, and other nautical, meteorological, and hydrographic instruments, most of which have been in service since the late war, and could only be made useful by frequent repairs. The same conditions prevail with the running lights, sounding, signaling, and illuminating implements, and logs for measuring the ship's way, now in service; and it is also proposed to introduce the electric light on several ships during the next fiscal year.

II.—OCEAN SURVEYS.

For special ocean surveys and the publication thereof (act of March 3, 1885).. 3(

NOTE.—Last year the sum of $20,000 was asked for and $10,000 appropriated; the amount estimated for the next fiscal year is $30,000.

It is proposed to continue the U. S. S. Ranger in surveying on the Pacific coast; in sounding in the track of the Pacific Mail steamers, and examining reported rocks and shoals in the North Pacific Ocean; it is further proposed to have the U. S. S. Thetis make surveys and soundings along the Spanish Main, and eventually to transfer her to the South Pacific to examine the many reported dangers to navigation now on charts. The amount asked for includes also the publication of surveys, which involves the slow process of drafting and engraving; for which reason it is recommended that the appropriation be made continuous.

III.—PUBLICATION OF SURVEYS OF MEXICAN COAST.

For repairing and engraving on copper-plates the surveys of the Mexican coast (submitted) ....

It is recommended that these appropriations be made continuous, as the work of surveying, drafting, and engraving may extend over the time to which the usual annual appropriations are limited.

IV.—OBSERVATIONS, TRANSIT OF VENUS.

For completing the reductions of the observations of the transit of Venus (to be expended under the direction of the Transit of Venus Commission) (submitted) ....

V.—NEW NAVAL OBSERVATORY.

For commencing the erection of the new Naval Observatory and necessary buildings upon the site purchased under the act of Congress approved February 4, 1880 (21 Stat., page 64) (submitted) ....

VI.—Compass-Testing Houses.

For completing compass-testing houses and furniture for same (submitted)	$2,000

VII.—Publication of Professional Papers.

For publication of professional papers (submitted)	12,000

VIII.—Contingent, Navigation.

For contingent expenses of the Bureau of Navigation, namely: For freight and transportation of navigation materials, postage and telegraphing on public business, advertising for proposals, packing-boxes, and materials, furniture, stationery, and fuel for navigation offices at navy-yards, and all other contingent expenses (act of March 3, 1885)	5,000

Note.—The amount under this head ($5,000) is the same as asked for last year; the amount appropriated for the current year is $4,000.

In the deficiency act of March 3, 1885, two items were appropriated to cover deficiencies in the years 1883 and 1884, and it is probable that in the final settlement of the contingent for the year ending June 30, 1885, a deficiency will result.

Since the Tallapoosa has ceased to carry freight, expenses under this head have naturally increased, and the practice of supplying our foreign squadrons with stores of American manufacture, such as lard oil, bunting, stationery, &c., entails increased freight bills.

IX.—Naval War College.

For repairs and improvements on Naval War College buildings, heating, lighting, and furniture for same, books and stationery, freight, and other contingent expenses (act of March 3, 1885)	8,000
For facing college building with Portland cement (submitted)	2,850
For purchase of feed and maintenance of horses and mail-wagon, and attendance on same (submitted)	1,550
For clerk to commandant or senior officer (submitted)	1,000
For attendant on buildings (submitted)	600
Total	14,000

X.—Civil Establishment.

New York navy-yard:	
For one clerk	1,400
For one writer	1,000
For one storekeeper	900
For one master of tugs	1,500
Portsmouth navy-yard:	
For one clerk	1,000
Boston navy-yard:	
For one storekeeper	900
League Island navy-yard:	
For one storekeeper	900
Norfolk navy-yard:	
For one clerk	1,200
Washington navy-yard:	
For one clerk	1,000
Mare Island navy-yard:	
For one clerk	1,000
Total	10,800

Note.—The amount appropriated for the current year ($5,000) has been applied to the payment of the following clerks, viz:

Portsmouth	$1,000
New York	1,400
k	1,200
Island	1,000
for four months	400

ing eight months the person doing the clerical work at Wash- id from the appropriation "Navigation," at $3 per diem, as lman; at Boston and League Island, one laborer each is

engaged in taking care of stores and keeping accounts at $2 per diem from "Navigation." It is proposed to employ a properly qualified storekeeper at each of these yards in place of the laborers, at $900 per annum.

The estimates submitted comprise also the pay of a writer and storekeeper at New York, who are now paid from "Navigation," as well as the pay of a master of tugs at New York, at $1,500 per annum, who by Department's order of October 6, 1884, is paid alternately by Ordnance, Navigation, Construction and Repair, Equipment and Recruiting, and Steam-Engineering.

RECAPITULATION.

FOR THE SUPPORT OF THE BUREAU OF NAVIGATION.

A.—I.	Salaries, Bureau of Navigation	$
	Salaries (submitted)	
B.—I.	Salaries, Office Naval Intelligence	
C.—I.	Salaries, Office Naval Records of the Rebellion	
	Salaries (submitted)	
II.	Contingent expenses	
D.—I.	Salaries, library, Navy Department	
II.	Books, library, Navy Department	
E.—I.	Salaries, Hydrographic Office	
	Salaries (submitted)	
II.	Contingent and miscellaneous expenses, Hydrographic Office	
F.—I.	Salaries, Naval Observatory	
	Salaries (submitted)	
II.	Contingent and miscellaneous expenses, Naval Observatory	
	Contingent and miscellaneous expenses (submitted)	
G.—I.	Nautical Almanac	
	Total	

FOR THE NAVAL SERVICE.

I.	Navigation	1
II.	Ocean surveys	
III.	Publication of surveys of Mexican coast	
IV.	Observations, Transit of Venus	
V.	New Naval Observatory	2
VI.	Compass-testing houses	
VII.	Publication of professional papers	
VIII.	Contingent navigation	
IX.	Naval War College	
X.	Civil establishment	
	Total	4

Statement of amounts expended at navy-yards for the pay of persons employed on cleri during the fiscal year 1884–'85, *and of the amounts required for the fiscal year* 1(*(act of January* 3, 1885, *section* 3).

Navy-yards.	Appropriations.	Amounts expended, 1884–'85.	Amo qu 188
Portsmouth	Civil establishment	$1,000 00	$
Boston	do		
Do	Navigation	643 05	
New York	Civil establishment	1,400 00	*
Do	Navigation	1,879 30	
League Island	Civil establishment		
Do	Navigation	616 00	
Norfolk	Civil establishment	1,200 00	
Washington	do	400 00	
Do	Navigation	609 00	
Mare Island	Civil establishment	1,000 00	
Total civil establishment		5,000 00	
Total navigation		3,747 35	
Grand total		8,747 35	

* This amount includes one clerk ($1,400), one writer ($1,000), one storekeeper ($900), and o ter of tugs ($1,500).

...nt of labor, purchases, receipts and expenditures at navy-yards during the fiscal year 1884–'85 (*Revised Statutes, section* 429).

Objects.	Portsmouth.	Boston	New York.	League Island.	Norfolk.	Washington.	Mare Island.	Totals.
Expended for mechanics and laborers, in equipping vessels of the Navy, and in receiving and securing stores for the same purpose	$898 12	$674 69	$10,836 46	$18 10	$763 81	$6,316 47	$884 37	$20,392 02
Materials and stores purchased	5,664 88	....	21,749 19	16 14	420 56	189 17	606 45	28,646 39
Cost or estimated value of stores on hand July 1, 1884	16,546 44	25,261 38	84,867 83	15,868 76	30,989 16	32,634 20	44,556 90	250,724 67
Cost or estimated value of articles received in 1884–'85	16,495 20	8,093 45	100,275 30	1,944 49	16,383 43	25,167 79	18,726 88	187,086 54
Cost or estimated value of articles expended in 1884–'85	19,672 93	7,769 64	75,469 82	2,870 13	22,819 90	27,737 67	19,601 62	175,941 71
Cost or estimated value of articles on hand June 30, 1885	13,368 71	25,585 19	109,670 51	14,943 13	24,552 69	30,064 32	43,682 16	261,866 71
Amounts realized from sales of condemned materials during fiscal year 1884–'85	....	....	757 90	....	....	....	1 80	759 70

REPORT OF SUPERINTENDENT NAVAL WAR COLLEGE.

UNITED STATES NAVAL WAR COLLEGE,
Newport, R. I., September 30, 1885.

SIR: I have the honor to inform the Bureau that the first term of t War College ended to-day.

As a matter of record it may not be out of place to state that under da of May 3, 1884, the Department directed a board of naval officers "report upon the whole subject of a post-graduate course * * for officers of the Navy, &c." The report of the Board, dated Ju 13, recommended in the most emphatic terms the adoption of a p graduate course; and on the 6th of October following, General Oru No. 325 announced to the service the establishment of the United Stat Naval War College.

A copy of the report of the Board and the order authorizing the C lege are herewith appended as part of the record.

Soon after the promulgation of General Order No. 325, instructio were issued to the following named officers to prepare themselves f duty as members of the college faculty, to wit: Capt. A. T. Mahan, S. N., to prepare to instruct in naval history and naval tactics; Pr James Russell Soley, U. S. N., to prepare a course of lectures in inte national law, and Paymaster R. W. Allen to prepare himself to instru in naval law and the administration of justice.

In accordance with the recommendations of the Board, that the scien and art of war "would be best taught by one learned in military science the Department made application to the Hon. Secretary of War for tl detail of an Army officer to take charge of that branch of the co course.

In compliance with this request, Lieut. Tasker H. Bliss, First Artiller U. S. Army, was assigned to the duty, and I may say here, in passin that the choice was an exceedingly fortunate one for the College. B Captain Mahan, who was at this time on the Pacific station in co mand of the U. S. S. Wachusett, was not ordered home in time to allo him to prepare his work, and Paymaster Allen was subsequently signed to other duty, leaving Professor Soley and Lieutenant Bliss only regular instructors.

To make good the deficiency, the services of other officers were as for.

Medical Director Richard C. Dean was invited to give a course of l ures on naval hygiene; Rear-Admiral Daniel Ammen was request give a lecture on any topic connected with naval warfare he might se and Commanders Henry C. Taylor and William Bainbridge Hoff asked for for similar service; but of the four officers named, Commander H. C. Taylor, was ordered by the Department. miral Ammen, being on the retired list, was not subject to orde he generously volunteered his services and to travel at his o pense.

As it was necessary to supply other lecturers besides the two r instructors named, personal solicitation was resorted to wi piest effect, as the following list will show:

Rear-Admiral Daniel Ammen read a lecture to the class on the September covering subjects of vital importance to the naval and containing some valuable hints to naval officers.

September 17.—General J. C. Palfrey, formerly of the Unit Army, but now a citizen of Boston, read a lecture on the I campaign of 1862.

September 21.—General George H. Gordon, formerly of the Army, but now in civil life, delivered a lecture on Pope's campaign in Virginia.

On the 22d, Commander Taylor read his paper, the subject being the necessity of concentration in the formation of the naval line of tle; and on the 28th, Mr. John C. Ropes, of Boston, a gentleman widely known for his extensive and accurate knowledge of military history, delivered a lecture on the Virginia campaign, which included the s of battles from the Wilderness to Cold Harbor.

t. E. O. Matthews had kindly consented to read a paper to the s, and he had been set down for the 29th, but he was assigned to duty just before the date fixed upon, and was obliged to leave town.

Of the three military lectures it is but just to say that they were of highest order of excellence and contributed very materially to the success of the course. I gladly avail myself of this occasion to make formal acknowledgment and to express my gratitude to the several gentlemen named.

The first of these three military lectures treated of the engagements ween ships and shore batteries, and was not only very instructive, but wholly within the line of our studies. The other two lectures were illustrated by military maps and gave in the most graphic manner the principal features of the campaign. As lessons in grand tactics and strat they were of very great value. But, however much importance y be attached to lectures of this class, I would hardly venture a second to solicit these voluntary contributions to our regular course, un here should be some means provided for defraying the expenses of who accepted an invitation to lecture.

To this end I would recommend that a small sum, not exceeding $500, be asked for of Congress to cover expenditures of this character.

Among those who were invited to lecture, but who for various rea were obliged to decline, was Mr. John Ericsson, of New York. In a very courteous letter that gentleman said that it would afford him much pleasure to present to the class under instruction his views on defensive naval warfare but for engagements which demanded his attention at the time named in the invitation.

A general but very informal invitation was extended to the officers of the Marine Corps, through the colonel-commandant, but the time was too short to admit of acceptance on the part of those willing to prepare lectures.

Of the regular course of lectures on international law and military nce, I am happy to be able to say that they more than realized my expectations.

The lectures of Professor Soley are so admirably adapted to the wants val officers that they must hereafter form an indispensable parts our system of professional education. Indeed, I am forced to the clusion that the branch of international law which he treats of in h a masterly manner belongs to and is inseparable from a thorough rse of the study of war. It can no longer be considered a separate partment of study.

Lieutenant Bliss, having been detailed for duty at the college but two ths prior to the commencement of the term, had but little time to pare his lectures, yet his intimate knowledge of military history and familiarity with the standard works of military writers enabled him acquit himself with credit. The experience gained during the term his great interest in the work will enable him to still further perfect elf for the duty to which he has been assigned.

In addition to the foregoing, there were read to the class four papers on naval topics.

There were no recitations required of the class, and no original papers called for.

Taken as a whole, there is every reason to be satisfied with the results of the term, and good grounds for expecting still better results in the future.

The full development of the college course must be a question of time. But with instructors deeply interested in their work and the many officers desirous of professional improvement, from which to form classes, that time need not be very far distant. Of the great influence on our future Navy even a moderate development of the course must exercise no one can doubt who has even a slight acquaintance with what has already been accomplished.

Estimates for further repairs and improvements of the college building and for books to complete the library have been submitted.

It is hoped that the Department will ask for the necessary appropriations of Congress and commend to that body the favorable consideration of this important institution.

Very respectfully, your obedient servant,

S. B. LUCE,
Commodore, U. S. Navy.

Capt. JOHN G. WALKER, *U. S. Navy,*
Chief of the Bureau of Navigation.

[Senate Ex. Doc. No. 68, Forty-eighth Congress, second session.]

Letter from the Secretary of the Navy, reporting, in answer to Senate resolution of the 4th instant, the steps taken by him to establish an advanced course of instruction of naval officers at Coasters' Harbor Island, Rhode Island.

NAVY DEPARTMENT,
Washington, February 11, 1885.

SIR: I have to acknowledge the receipt of a copy of a resolution adopted by the Senate on the 4th day of February, as follows:

"*Resolved*, That the Secretary of the Navy is hereby directed to report to the Senate what, if any, steps have been taken to establish an advanced course of instruction of naval officers at Coasters' Harbor Island, Rhode Island, and the reasons which have controlled the action of the Department."

The subject of an advanced course of instruction of naval officers was, May 3, 1884, committed by this Department to a Board consisting of Commodore S. B. Luce, Commander W. T. Sampson, and Lieut. Commander C. F. Goodrich, who on the 13th of June, 1884, made a report recommending the establishment of such a course of instruction in the science and art of military and naval warfare and in international law and history. The method recommended is carefully outlined in the report, a copy of which is annexed to this communication.

As it was deemed advisable that the course of study should be made to supplement the present instruction of naval officers in torpedoes at Newport, R. I., and that the place should be selected where the Department is already in possession of the necessary grounds and buildings, the Board recommended the establishment of the college of instruction at Newport.

In pursuance of the previous determination of the Department, and in accordance with the foregoing report, directions were given that preparation should be made for the course of instruction to be conducted at Coasters' Harbor Island, in Newport, by General Order No. 325, issued October 6, 1884, a copy of which is herewith transmitted.

The reasons which have controlled the action of the Department are to be found in the recognized necessity for an advanced course of military and naval education in the United States. There are now existing three schools for the purpose in the Army and one in the Navy. The latter is at the Torpedo Station at Newport, where a class of officers s assembled for a few months in each year for instruction in the art of manufacturing

and using torpedoes and torpedo explosives. The constant changes in the methods of conducting naval warfare imposed by the introduction of armored ships, swift cruisers, rams, sea-going torpedo-boats, and high-power guns, together with the more rigid methods of treating the various subjects belonging to naval science, render imperative the establishment of a school where our officers may be enabled to keep abreast of the improvements going on in every navy in the world. The Torpedo School only partially fulfills the imperative requirements. The college is intended to complete the curriculum by adding to an extent never heretofore undertaken the study of naval warfare and international law and their cognate branches.

The great surplus of officers in the Navy makes it especially appropriate to require that at all times some of them not needed for actual duty shall be engaged in courses of professional study calculated to improve and qualify them for better service in the future.

In instituting this school of instruction at Coasters' Harbor Island, the Department, acting within the scope of its powers, has simply utilized public grounds and buildings under its own immediate control for a wise and beneficial purpose, and has detailed naval officers who can readily be spared to constitute the president and faculty of the college.

Very little expense will be incurred in carrying out the Department's plan, while the benefits to be realized by the Navy and the country will be of great importance. The subject is commended to the notice and favor of Congress.

Very respectfully,

W. E. CHANDLER,
Secretary of the Navy.

The PRESIDENT PRO TEMPORE OF THE SENATE.

REPORT OF BOARD ON A POST-GRADUATE COURSE.

UNITED STATES TRAINING SQUADRON,
UNITED STATES FLAG-SHIP NEW HAMPSHIRE (First rate),
Newport, R. I., June 13, 1884.

Hon. WILLIAM E. CHANDLER,
Secretary of the Navy, Washington, D. C.:

SIR: The Board appointed by the Department under date of May 3, to "report upon the whole subject of a post-graduate course, or school of application, to be established by the Department for officers of the Navy, giving in detail the reasons for establishing such school, the scope and extent of the proposed course of instruction, and an opinion as to the best location therefor," have the honour to submit the following preliminary report.

If the recommendations contained herein meet with the approval of the Department, the Board is ready to develop the plan in greater detail:

FIRST.—THE REASONS FOR ESTABLISHING SUCH A SCHOOL.

The variety and extent of knowledge now required of a naval officer demands a longer period than was formerly considered necessary to cover a complete course of technical education. Of this knowledge certain branches are acquired and assimilated with greater ease by minds more matured than those of the average undergraduates of the Naval Academy.

It is found that numbers of young officers after a little experience at sea take up of their own accord those studies for which they have developed a taste; it may be ordnance, astronomy, electricity, steam, history, international law, or the languages. There are others who, possessed of undoubted ability, do not exert themselves in the direction of self-improvement for want of proper facilities, or, perhaps, of an incentive—men who could take a high stand in almost any branch were the opportunity offered or the motive power applied.

For years past the Bureau of Ordnance has recognized the existence in the service of a large amount of talent that could be utilized for its own special purposes, and it has always encouraged officers to qualify themselves in that particular line. It now finds its reward in a body of capable and efficient assistants.

The present admirable post-graduate course at the Torpedo Station is due solely to the enlightened policy of that Bureau.

In the establishment of the proposed school the Navy Department would be doing for all professional branches what the Bureau of Ordnance has been long doing to supply its own particular needs. It would, moreover, consolidate the instruction in each into a well organized and homogeneous system.

The Board is of the opinion that a cogent reason for such a school is that there may be a place where our officers will not only be encouraged, but required to study their profession proper—war—in a far more thorough manner than has ever heretofore been attempted, and to bring to the investigation of the various problems of modern naval warfare the scientific methods adopted in other professions.

Although the science of war cannot be mastered through the agency of books alone, yet a complete study of the operations of war, both on land and sea, by which the principles of the science have been illustrated practically, is absolutely essential to the proper education of the officer whose life is dedicated to the profession of arms.

Campaigns that have depended for success upon the co-operation of a fleet; campaigns that have been frustrated through the interposition of a fleet; the transfer by water of a numerous army to distant points and their landing on an enemy's coast under the guns of a fleet; the various results of the engagements between ships and shore batteries; naval expeditions which have ended in disaster that could have been foretold through an intelligent study of the problem beforehand; and the great naval battles of history, even from the earliest times, which illustrate and enforce many of the most important and immutable principles of war, should be carefully examined and rendered familiar to the naval student. For it is upon his professional skill in the larger operations of combining and utilizing to the best advantage the floating force of the country, as well as in the more restricted one of an isolated command, that our people must rely for the protection of their interests and the guarding of their extensive coasts and coasting trade from the depredations of an enemy.

The almost total absence of an adequate naval force adds to the burden of responsibility imposed upon our naval officers, and imperatively demands of them extraordinary exertion in the acquisition of professional knowledge in order to make such amends as they best may for the extreme paucity of the means furnished them. Here, then, is not simply a "reason," but an absolute necessity for the establishment of such a school as the order contemplates.

In regard to that valuable practical experience which can be gained only by service afloat, the American naval officer is at a great disadvantage. It is well known that the channel squadron of Great Britain and the squadron of evolutions of France, made up of line-of-battle ships of the most recent types, have long been the great naval war schools of their respective countries, while the naval officers of all maritime nations, great and small, including Chili, China, and Japan, enjoy the opportunities denied to our officers of duty on board of modern fighting ships. This very serious defect in our naval organization can only be partially remedied, if at all, by the proposed war school.

The bare statement that our naval officers not only do not study war as a science, but have no adequate school of practice, seems in these days of broad and liberal culture so extraordinary that it is alone, in the judgement of the Board, sufficient reason for the early founding of the institution which the Department now has under consideration.

But there are other weighty reasons.

Naval officers are often called upon on foreign stations to exercise diplomatic functions, and are not unfrequently required to settle or act upon questions involving nice points of international law. They should, therefore, be carefully prepared for this responsibility by an intimate knowledge of the enlightened neutrality policy which this country has had the honor of introducing and maintaining from its foundation, and of the principles of equity that have ever characterized, as well as of the instruments which control the intercourse of the United States with foreign powers.

Thorough instruction in international law may therefore be regarded as an essential feature in the higher education of the naval officer. This can best be supplied by a post-graduate course.

The study of war and law especially should be undertaken by minds more matured than can be found among the average undergraduates, and by deferring it to the time when the officer is about to assume the greater responsibilities of higher rank the full weight of these subjects is better appreciated, and their acquisition far more likely to engage his best energies.

A more extended course in mechanics, gun construction, &c., is necessitated by the very great advances that are being constantly made in ordnance; while recent hydrographic work, the exact determination of latitudes and longitudes, in the many cases where this still remains to be effected, the addition of iron ships to the Navy, involving the necessity of precise evolution of their magnetic constants, &c., show how imperative is the demand for higher instruction in surveying, nautical astronomy, and practical physics.

In giving prominence to the subjects of war and law, as studies to which the greatest importance should be attached, and to the acquisition of which the highest efforts, stimulated in what manner soever the Department may judge wisest, should be applied, the Board is by no means insensible to the great value to the country of work that may be

accomplished by the Navy in time of peace; work, too, such as may be strictly in the line of professional improvement, and such as, by training the faculties and extending the mental horizon, still further prepares the officer for the more varied demands made in time of war upon his intelligence and attainments. As the domain of human knowledge becomes more and more enlarged, the field of professional requirements expands to such an extent that it must be pastured out, as it were. Thus the tendency in the Navy, as in all other professions, is towards the formation of specialties. It is to the specialist that we are indebted, mainly, for the vast accessions which have been made of late years to common stock of knowledge. But it is for the very reason that the victories won in ace and the great variety and attraction of the studies open to the naval officer may, sometimes do, lead him away from his true pursuit, that we urge the early opening of a school where war, the one subject *par excellence* of the naval profession, may be taught as thoroughly as it can be taught outside of the stern school of the field of battle.

Failing to produce specialists in this one branch, we fail utterly in our whole system of naval education, for all others are but subordinate or accessory.

In the earnest prosecution of what is but a means to an end, the officer is too apt to lose sight of the ultimate object of all. Thus, electricity in its application to torpedoes, chemistry in its application to explosives, metallurgy in relation to ordnance, and steam as a motive power, are only means to the end for which a navy may be said to exist—success in war. The establishment of the proposed school, by opening to officers the higher branches, will serve to correct any misapprehension on this point and dissipate the haze which to a greater or less extent obscures the perception in regard to the true aim of naval education and duties of naval officers.

The war school will, moreover, furnish an admirable opportunity for healthy, intellectual development, and gratify the laudable desire so general among our officers for increased knowledge. While preventing erratic flights into fields of research unrelated to his calling, some of which might unfit him for its stern duties, the school will tend to hold the young officer to those lines of professional thought so eminently calculated to qualify him for his highest and most responsible duties.

That the study of war may well engage all the faculties of the brightest minds and be worthy of a special school is shown by the fact that in the world's history few have been found to whom can be assigned the proud title of master of the art.

SECOND.—OUTLINE OF THE PROPOSED COURSE.

It is assumed that six months will be needed for the work of the war school.

The course may, with propriety, be made to supplement the present instruction in torpedoes at Newport. The two together would cover a period of less than a year.

It is proposed to divide the teaching at the war school under two heads:

A. The science and art of war.

B. Law and history.

The course in "war" should include the following subjects:

1. Strategy and tactics.
2. Military campaigns.
3. Joint or opposed military and naval operations, treated from the military standpoint.
4. Disposition and handling of seamen landed for military service.
5. Elements of fortifications and intrenchments.
6. Naval strategy and tactics.
7. Naval campaigns.
8. Joint or opposed military and naval operations, treated from the naval standpoint.

As the principles underlying all hostile movements are at bottom the same, whatever be the nature of the field of action, the Board is of opinion that an intimate knowledge of military operations is essential to the naval strategist, and it suggests that the first five of the above-mentioned subjects would be best taught by one learned in military science.

The course in law and history ought to embrace—

1. International law.
2. Treaties of the United States.
3. Rules of evidence.
4. General naval history.
5. Modern political history.

The first subject is of the utmost importance in its bearing upon the action taken by our naval commanders abroad. In the judgment of the Board the most eminent author- of the day should be engaged to undertake the elucidation of its principles; and, also, ...ing out clearly the nature and extent of our treaty obligations.

... third subject, on account of its relation to sound administration of justice and law, ought to be expounded by a distinguished member of the legal profes-

PRACTICAL EXERCISES.

The North Atlantic squadron affords the nearest approach to be found to a p
course in naval tactics. It should be assembled once a year, and during a stated p
go through a series of fleet evolutions, gunnery practice with the latest types of ordna
the landing of seamen for military operations, boat expeditions, torpedo attack and
fense, &c., having the class on board for instruction.

It is to be hoped that at no distant day these exercises may be supplemented by p
tice with torpedo boats of exceptionally high speed.

In order to carry out the recommendations contained in the introductory portio
this report it will eventually become necessary to provide additional courses, which s
fit officers so desiring for the peculiar work exacted by the increased complexity of
tain branches of the profession.

The following table contains the studies, &c., which we think should be complete
those who wish to qualify as specialists in ordnance, torpedoes, and hydrography.

In time it is probable that other courses may be found necessary.

1. *Theory.*

Ordnance.—Higher mathematics, physics, mechanics, chemistry, mechanical draw
Torpedoes.—Higher mathematics, physics, mechanics, chemistry, mechanical draw
Hydrography.—Higher mathematics, physics, nautical astronomy.

2. *Practice.*

Ordnance (at Washington naval arsenal and experimental battery).—Machinery, m
working, ordnance, gun-construction, inspection of guns, fuses, small-arms, &c.

Torpedoes (at Torpedo Station).—Electricity in its various professional applicat
explosives, torpedoes.

Hydrography.—Sketching, surveying, cartography, use of portable and fixed a
nomical instruments.

The Board confines itself to pointing out the lines along which it is probable that t
specialties will find their study—development; but it is not prepared to urge the in
diate establishment of these courses as essential to the organization of the war sc
which, as already shown, is a pressing necessity.

No one should be permitted to engage in these courses who cannot pass a satisfa
examination in those matters, now so well taught at the Naval Academy, and whic
to be resumed in the post-graduate course. It is proposed to take the student ex
where Annapolis left him and carry him still further along the path of science unde
care of eminent specialists in each branch and to afford him the advantage of the
apparatus and appliances available.

In the absence of material rewards and as an inducement to officers to undertak
serious labor involved in acquiring these specialties, the Board suggests that those
finish the instruction with credit should receive certificates of proficiency, and that s
nificant letter or other mark should be placed opposite their names in the Navy Reg
In this connection, the Board ventures to express a hope that every officer's useful at
ments, such as foreign languages, sketching, photography, draughting, surveying, p
ing, naval architecture, &c., may form a part of his record at the Navy Department,
his fitness for any special work may be known and utilized.

The Board is of the opinion that the facilities of the war school should be deni
officers below the grade of lieutenant, in order that a proper amount of preliminar
service may be secured.

If these special courses are established, it may be well to allow any officers who d
it, and whose services the Department can spare for the time being, to attend th
struction in one or more of the subjects taught.

Instruction in modern languages, as well as in water colors and photography, is d
able, and would bring its own reward on the one hand in foreign service and on
other in military and naval reconnaissances. The Board believes these subjects m
time be added as optionals with advantage.

THIRD.—LOCATION.

In considering the location of the proposed war school the Board has felt that
important question must be mainly decided by the facilities for the required instru
presented by the various places which have suggested themselves, such as Washin
Annapolis, New York, Newport, and Boston.

It has been thought important that the place should be selected where the De

is already in possession of the necessary grounds and buildings. This first condi-
ppears to be satisfied by both Newport and Boston. At the former place, Coasters'
r Island would furnish a suitable location. At Boston it is assumed that the
r accommodation could be had at the navy-yard.

1 the more important matter of the facilities furnished by these two cities is con-
ed each is found to have its claims, though they are quite different in character.
ewport possesses a site at which the school could be permanently established, and
re there is little probability that its welfare would clash with any other interest of
service. The Torpedo Station is already at this place, and it would be possible to so
end its facilities that the instruction in physical science might be given—although
vould entail a considerable outlay for buildings, apparatus, &c., as well as a yearly
penditure for instructors. As practical exercises afloat ought to constitute a part of
e course at the war school, Newport offers exceptional advantages.

Boston, on the other hand, possesses the facilities of a great university and technical
ools, including eminent professors and excellent libraries. If these can be made
ailable in providing the necessary instruction in science, it is thought that the scheme
y be put into operation at once and at small expense. The character of the instruc-
n aimed at in the proposed school is of the highest order and would demand the
vices of the ablest instructors in each department. It is for this vital reason that the
d is of the opinion that to secure such instructors all other considerations should be
med subordinate.

In the case of the two main branches, the science of war and international law, the
uctors should come to the school; while in the courses in science the pupils must
o the instructors, wherever such, together with the necessary laboratories, are to be
nd. The number of officers to take such science courses would probably not exceed
annually.

he Board therefore recommends that the war school be established at Newport, and
t those officers who take these special courses in science avail themselves of the great
itutions of learning at Boston.

n looking forward to the complete organization of the school the Board are of the
ion that the recommendation here made is not only practicable but would produce
ter results than any other plan.

Very respectfully submitted.

S. B. LUCE,
Commodore, U. S. Navy, President of the Board.
W. T. SAMPSON,
Commander, U. S. Navy, Member.
C. F. GOODRICH,
Lieutenant-Commander, U. S. Navy, Member.

ESTABLISHMENT OF NAVAL WAR COLLEGE.

ERAL ORDER No. 325.

NAVY DEPARTMENT,
Washington, October 6, 1884.

A college is hereby established for an advanced course of professional study for naval
s, to be known as the Naval War College. It will be under the general supervision
Bureau of Navigation. The principal building on Coaster's Harbor Island, New-
R. I., will be assigned to its use, and is hereby transferred, with the surrounding
ures and the grounds immediately adjacent, to the custody and control of the Bureau
igation for that purpose.

college will be under the immediate charge of an officer of the Navy, not below
ade of commander, to be known as the president of the Naval War College. He
e assisted in the performance of his duties by a faculty.

course of instruction, embracing the higher branches of professional study, will be
l by a Board, consisting of all the members of the faculty, and including the presi-
ho will be the presiding officer of the Board. The Board will have regular meet-
t least once a month, and at such other times as the president may direct, for the
tion of business. The proceedings of the Board will be recorded in a journal.

course of instruction will be open to all officers above the grade of naval cadet.

odore S. B. Luce has been assigned to duty as president of the college.

WILLIAM E. CHANDLER,
Secretary of the Navy.

REPORT OF SUPERINTENDENT OF NAVAL OBSERVATORY.

UNITED STATES NAVAL OBSERVATORY,
Washington, October 5, 18

SIR: Pursuant to the Bureau's instructions of the 24th ultimo, I the honor to submit herewith the report of the operations of the Na Observatory during the past year.

Rear-Admiral S. R. Franklin, U. S. N., continued in the duties of Superintendent until the 31st March of the current year, when he was detached therefrom in order to assume command of the United States naval force on the European station. In the interim from that d until the 1st of June, 1885, Commander A. D. Brown, U. S. N., actea as Superintendent, when, under the orders of the Department, I assumed the duties of the office.

Finding everything pertaining to the organization of the institution, and the methods pursued, in as good working condition as the present means and force admit, no change has been made either in system or detail.

THE 26-INCH EQUATORIAL.

This telescope has continued in charge of Prof. A. Hall, U. S. N., who has been employed in observing the satellites of the large planets and in observation of double stars.

Though in constant use, the instrument, together with its micrometer, driving clock, and other apparatus, remains in good working order, and the dome, 43 feet in diameter, covering it, is now revolved with great ease by means of the 4 horse-power gas-engine which was connected with it in the latter part of 1884. The dome is now turned to any position required in a few minutes, and the work of observing is much facilitated. Mr. George Anderson has charge of the engine, and assists Professor Hall in the management of the dome.

The complete reduction and discussion of the observations made with this instrument have made good progress during the past year. This is due, in a great measure, to the efficient aid rendered by Lieut. W. H. Allen and Ensign J. A. Hoogewerff, U. S. N. These gentlemen have been very diligent in making the necessary computations, and have shown marked aptitude for the work.

The observations of the satellite of Neptune and those of the two outer satellites of Uranus have been discussed, and the masses of these planets deduced. These results have been published in Appendices I and II of the annual volume of the Observatory for the year 1881.

A discussion of all the observations of Iapetus, the outer satellite of Saturn, is now nearly finished, and will be ready for printing in a few weeks.

TRANSIT CIRCLE.

This instrument is in charge of Prof. J. R. Eastman, U. S. N., assisted by Assistant Astronomers Skinner, Winlock, and Paul, and has been employed, as in the last few years, in the observations of: (1) Stars of the

American Ephemeris for the determination of clock and instrumental corrections. (2) The sun, moon, and major and minor planets. (3) Miscellaneous stars, comprising those used as comparison stars in observations of minor planets and comets, and those necessary to complete the observations for the proposed catalogue of stars observed with the transit circle.

Since the last report 5,520 observations have been made. Of these, 90 were of the sun, 70 of the moon, 156 of the major planets, and 64 of the minor planets.

The labor of preparing the copy and reading the proof of the volumes for 1881 and 1882 has taken such a large portion of the time of the observers and computers that the computations for the work of 1883 and 1884 have been greatly delayed. These computations are now progressing as fast as possible with the present force.

THE 9.6-INCH EQUATORIAL.

This instrument remained in charge of Commander W. T. Sampson, U. S. N., with Prof. Edgar Frisby, U. S. N., as assistant, until October 28, 1884. Professor Frisby was placed in charge April 2, 1885.

The work of the instrument has been confined to: (1) Observations of comets, six of which have been systematically observed during the year. These observations have all been reduced to date, and published in various astronomical journals in this country and Europe; elements of Barnard's comets were computed, the first of which were published in the Astronomische Nachrichten. (2) Observations of asteroids, principally of such as could not be observed with the transit circle on account of their faintness or their position; thirty-five regular observations of asteroids were made, and twenty-one approximate positions of other asteroids obtained, so that they could readily be observed with the transit circle. (3) Occultations of stars by the moon, whenever practicable. (4) Doubtful observations of stars and asteroids made with other instruments were looked up and decided, this being probably one of the most important uses of the equatorial.

A few observations have been made of the variable star in the nebula of Andromeda, which show that the star is decreasing in brightness. Assistant Astronomer Winlock has made several observations of comets, with drawings of their physical peculiarities and changes of appearance.

THE PRIME VERTICAL INSTRUMENT.

The work of reducing the observations made in 1883–'84 by Lieut. C. G. Bowman and Ensign H. Taylor, U. S. N., for the determination of the constant of aberration, has been pursued. A selection was made of twelve stars of varying right ascension and well determined places, and the results obtained; the reduction of the remaining observations will be proceeded with as rapidly as possible.

In July of last year a communication was received from the president of the International Geodetic Conference, asking the co-operation of this Observatory with the Royal Observatory at Lisbon in the determination of the problem of the change of latitudes, the observations to be taken with the prime vertical instruments of the two observatories. Communication was opened and correspondence is still in progress with the director of the observatory at Lisbon, and preparations have been made to undertake the work here very soon after it is known that it will be begun at Lisbon.

ANNULAR ECLIPSE OF MARCH 16, 1885.

In February last a circular was issued by the Superintendent, gi the names of various points in the path of the annulus of the eclipse o March 16, and the approximate times of the beginning of the annu phase; this was distributed throughout the sections of the country interested, by means of the Pacific Railway companies. The Western Union Telegraph Company also had the courtesy to extend the facilities of their lines for the transmission of the noon signals on the 15th and 16th March as far west as Sacramento and Delta in California. This was successfully done, and all observers had accurate comparisons with standard clock.

Reports were received from—

Mr. J. Blickensderfer, chief engineer, Union Pacific Railroad.
Mr. Francis D. Jones, Helena, Mont.
Mr. F. Hess, Fort Dodge, Iowa.
Mr. S. N. Griffith, Jamestown, Dak.
Mr. F. T. Taylor, Tacoma, Wash.
Mr. M. Winger, Cleveland, Ohio.
Mr. G. F. Goodhue, Bozeman, Mont.
Mr. William H. Kinnon, Bismarck, Dak.
Mr. W. W. Austin, Richmond, Ind.
Mr. William Hood, chief engineer, Central Pacific Railroad.
Mr. W. S. Palmer, Delta, Cal.
Mr. C. H. Rockwell, Delta, Cal.
Miss E. L. Muerner, Naperville, Ill.

Photographs were received from—

Mr. George L. Heath, Hastings, Mich.
Mr. —— Bayne, Grand Rapids, Mich.
Mr. George P. Lovegrove, Lakeview, Oreg.

No unusual phenomena were observed.

Observations of the first contact were made at this Observatory by Professors Hall and Frisby and Assistant Astronomer H. M. Paul. The difference of right ascension of the second limbs of the moon and sun was observed by Lieutenant Bowman on the east transit, and by Assistant Astronomer W. C. Winlock on the west transit.

Ninety-nine photographs of the various stages of the eclipse were tak with the photo-heliographic apparatus of the Transit of Venus Commi sion by a party consisting of Commander Brown, Ensigns Winterhalter and Taylor, and Mr. W. F. Gardner. The exposures were made and the negatives developed by Ensign Winterhalter; one-half the plates used were coated with gelatine; the other had the Transit of Venus emulsion, being over two years old. A number of these plates have been measured by Ensigns Hogg and Taylor, and the results given to the Superintendent of the Nautical Almanac in accordance with his request.

The data will soon be published.

THE MERIDIAN TRANSIT INSTRUMENT.

Lieut. C. G. Bowman, assisted by Lieut. John Garvin, U. S. N., has remained in charge of this instrument. The work has consisted principally of daily observations and reductions for clock corrections in connection with the time service. Observations for the right ascension of the sun, moon, and major planets were taken until June of the present year, when they were discontinued. The standard clock has continued to perform well. The east transit clock has been much improved

y an outer case with a considerable air space which has been built round it. The Kessels clock has during the present month been connected with the east transit chronograph, and as daily comparisons the time of observation are made with it, it is expected that it will serve as a useful check upon the performance of the other clocks.

Lieut. L. L. Reamey, U. S. N., has been employed during the greater rt of the year upon the reduction of the transit observations.

MURAL CIRCLE.

The work laid down in the programme for the mural circle has been ransferred to the Repsold meridian circle at the Naval Academy, Anapolis, through the co-operation of Capt. F. M. Ramsay, U. S. N., the uperintendent of that institution.

Prof. S. J. Brown, U. S. N., has been engaged in putting the instruent in order and in fitting up the observatory-room for the observations which will soon begin.

CHRONOMETERS AND TIME SERVICE.

This division of the Observatory has continued in charge of Lieut. E. C. Pendleton, U. S. N.

There are at present in the chronometer-room 240 chronometers, of hich 21 are ready for issue, 30 are on trial, 57 require repairs, and 132 e condemned, to be used only as backs.

During the year 39 chronometers were issued and 49 were received rom naval vessels and stations. Two chronometers that were purhased from M. F. Dent, of London, for use on the Greely relief ships Bear and Thetis, were received at the Observatory. Forty-five chroometers were sent to be cleaned and repaired, and 20 remain with essrs. T. S. & J. D. Negus, and Messrs. John Bliss & Co., of New ork, and Messrs. William Bond & Son, of Boston.

Two chronometers were loaned by order of the Bureau of Navigaion—1 to the Signal Office, 1 to the Department of the Interior—and were condemned.

The Bureau of Navigation having notified the chronometer makers f its intention to purchase 12 new chronometers after competitive rials, the firms of T. S. & J. D. Negus, John Bliss & Co., and William Bond & Son have signified their purpose to send to the Observatory ut 40 chronometers. They will be delivered during the month of ecember. The trials will commence January 1, 1886, and continue for x months. No chronometer will be admitted to competition that is ot essentially of American workmanship.

During the past year the demands upon the time service have greatly ncreased. In Washington, the number of clocks of the Gardner system n the various public offices has increased from 20 to 84. Under the rangement with the several Departments, the Observatory is held responsible for the condition of these clocks, which, with the exception of those in the Interior Department, are visited weekly, inspected, and wound. The clock circuit being largely composed of overhead wires, is subject to various interruptions and interferences by reason of its situation relative to other wires, and requires constant care and attention. The local batteries in the various buildings also require to be looked ter quarterly, and an appropriation has been asked for under the head of maintenance of time service to cover these and other expenses.

In this connection it may not be amiss to add that this clock system

is due to the inventive genius of Mr. W. F. Gardner, the instrum maker of the Observatory. Mr. Gardner has been at considerable sonal expense in perfecting this invention, which is becoming more more valuable every day, both to the Government and the public, it is submitted that he should receive due recognition therefor w Congress has an opportunity to look into the matter.

The plant at the Observatory has also been increased by the ad of a second transmitting clock and the purchase of electrical n uring instruments, by which the line can be tested at any time faults detected. Their value has been shown by the detection o juries to the Government cable on two occasions, the location of w could not otherwise have been determined. The battery requirem on account of the line have also been largely increased.

The adoption of the system of standard time created a deman a more correct time than had been the case, and the noon signal this point became of greater value than when the old system of times was in vogue. To answer this demand, and also to render service to the maritime community as they find in other countries, balls have been established by the Department at various points the Atlantic sea-board, and it is intended, if the appropriatio made, to place additional ones at important commercial points. advantage to the shipping community can hardly be overestim The Western Union Telegraph Company has given the use of its for the transmission of the necessary signals without charge. Th rect time is thus given to the representatives of the Departme Boston, Mass.; Newport, R. I.; navy-yard, New York; Philadel Pa.; navy-yard, Washington; Hampton Roads, Va.; Savannah, New Orleans, La.

Three minutes before noon of each day (the busiest time o twenty-four hours) are given up to these signals, and it is respect submitted that proper remuneration should be made to the teleg company.

The branch observatory at Mare Island, which is fitted with a d cate of the transmitting apparatus of this Observatory, has been nected with the mainland by a cable laid by the Western Union pany without any charge to the Department, and time signals transmitted daily along the Pacific coast. A time-ball has been er on the island for the benefit of the Vallejo shipping, and is dro daily at noon of the one hundred and twentieth meridian. The H graphic Office time-ball at San Francisco is also dropped at the instant by signal from the Mare Island Observatory.

The balls at Savannah and Hampton Roads are now hoisted dai volunteer labor. It is respectfully submitted that a reasonable pensation should be paid for this service, which will be done fro time-service appropriation when made.

The growth of Washington has rendered the Observatory time-b but little account; hence in May last a proposal was made fo transfer to the central pavilion of the Navy Department. Thi duly accomplished by the aid of Chief Engineer H. L. Snyder, U. the superintendent of State, War, and Navy Departments buil and since the 11th of July the ball has be d fr the s that point. The one at the Ob

The total number of time- r nal is eight, at the followi

Philadelphia, Baltimor

s; New York, Western Union building; Navy Department, Washton, navy-yard Washington, Hampton Roads, Savannah.
. ninth will soon be added at the torpedo station in Newport.

LIBRARY.

he library was in charge of Lieut. John C. Wilson, U. S. N., until 30th ultimo, when, owing to ill health, he requested his detachment i the Observatory in order to take a sick leave. He was succeeded ie duties of librarian by Lieut. L. L. Reamey, U. S. N., transferred i the meridian transit instrument.

he library is increasing rapidly in bulk and value, and the lack of age room and proper accommodations for those consulting its varied imes becomes more apparent from year to year.

contains, by actual count, 11,423 volumes; 2,283 pamphlets.

his is somewhat less in number of volumes than has been previously ed, but which is accounted for, in part, from the fact that in some ances paper-covered publications of two volumes when sent to the ler have been bound in one. The accessions to the library during year have been as follows:

mes	441
phlets	366
Total	807

se, there were received by exchange	579
urchase	228

he present list of exchanges contains:

ign addresses	436
stic addresses	474

he following publications of the Observatory have been received the Public Printer and distributed:

rogramme of work for 1885.
bservations of the Minor Planets, Professor Frisby.
rcular preparatory to Observations of Solar Eclipse March 16, 1885.
sults of Observations of March 16, 1885.
inual Volume for 1881.
eorological Observations, 1881.
eorological Observations, 1882.
ppendices I and II, Annual Volume, 1881.

following communications from the Superintendent have been ed for publication in the various astronomical journals:

rvations of Comet Wolf (Commander Sampson and Professor y).
rvations of Hyperion (Professor Hall).
rvations of Minor Planets (Professor Frisby).
rvations of Satellites of Saturn and Companion of Sirius (Pro- Hall).
ission of Proper Motion of Lacaille 16616 (Professor Frisby).
rvations of Comet Barnard (Professor Frisby).

printing of the annual volumes, which had fallen far behind, has iewhat advanced owing to the passage by Congress of a con- resolution for the publication of the volumes for 1881 and 1882. volume for 1881 has been printed and distributed as noted above, for 1882 is in the hands of the printer. The volume for 1883

will be ready next spring, and it is earnestly hoped that the additi computers estimated for will be granted, in order that the observat may be reduced and published within a reasonable time after they made.

On January 1 Professor Eastman was, at his own request, reliev the charge of the meteorological observations, and that work was t ferred to the control of the officer in charge of the library, and th servations have been taken by the watchmen as usual.

PHOTOGRAPHY.

In the programme of work proposed for the current year it was s that the work of taking sun photographs daily would be inaugurat soon as practicable. The work of the Transit of Venus Commissio up to this time prevented any regular system being adopted. work, if pursued systematically and continuously, would put this tution on a footing in this regard more nearly equal to that of the l foreign observatories where a large mass of data has been accumu for future measurement, computation, and discussion, forming the of much information of value to the student of solar physics.

For purposes of co-operation in this scientific work, photograph servations in different parts of the world being supplemental to other, it is also desirable that this work be begun, and sooner or it will have to be taken up here in order to keep pace with the re ments of modern astronomical research and observation. It ca therefore, be begun too soon.

It is eminently desirable that this Observatory possess a collecti photographs of astronomical subjects, and so be enabled to solic changes from astronomers abroad that are engaged in celestial ph raphy. But we lack the means and equipment for printing and ing photographic positives that can properly be used for such pur of exchange.

Much work is desirable to be done in photographing star clu nebulæ, and the spectra of sun-spots, stars, &c., and in the produ of star maps by photography. Should a party from this Observato sent to observe the total eclipse of 1886, photographs of the phenom will have to be taken. The Observatory should at all times be pre for such an occasion and have a staff drilled in photographic work this might be easily accomplished, as the number need not be great it could be made up of officers stationed here.

For all these purposes, and for work of a kindred nature, an esti of $1,000 has been submitted, which it is hoped will receive the f able consideration of Congress.

Through the courtesy of Professor Baird, of the Smithsonian In tion, Ensign Winterhalter has received a course of instruction in ph raphy, and is ready to prosecute work of this character.

NEW OBSERVATORY.

I beg to renew the recom ... essors for t moval, at an early day, of ... to the ne selected and purchased for ...

The plans, long since pr ... nent scientific men of th ... as the money is forthcom ...

ally three years to erect the buildings, transfer the plant, and get everyng into good working order.

The National Academy has been requested by the Department to ex-ss its opinion officially as to the advisability of proceeding promptly th the erection of the building, and it cannot be doubted that it will xpress itself affirmatively in the matter.

The disadvantages of the present location have been so often and so rcibly described that the subject is worn almost threadbare.

To the foresight and energy of officers of the Navy is due the inception and development of this institution. It is emphatically the child of the Navy, and the service is much interested in its welfare and in ery effort to extend the sphere of its usefulness. From its humble nning in 1838 it has now grown to be one of the most important asuomical centers in the world, and it is to be hoped that Congress will gnize the good work hitherto done by granting the means to place institution on a still higher plane than it now occupies.

BOARD OF VISITORS.

I also beg to renew the suggestion heretofore made that a board of visitors, composed of competent persons, be appointed annually to visit itution and inquire into its workings, with authority to suggest changes in the methods pursued, or such new lines of investigation, might deem proper to recommend. Perhaps the best constitution of a board would be a committee of Congress, acting in conjunction a number of gentlemen of well-known attainments and authority scientific world.

SOLAR ECLIPSE OF 1886.

A total eclipse of the sun will occur on the 29th of August, 1886. The line of totality passes over the equatorial portion of the Atlantic Ocean, and reaches the west coast of Africa near Benguela, in latitude 2° south. This port is easy of access, and as it is the healthy season, here would be no difficulty in sending a party out in a Government essel. The duration of the totality at this point is four minutes and rty seconds, affording a more than usually good opportunity for phographic and spectroscopic observations. The question as to the proty of applying for an appropriation to defray the expenses of an serving party has been referred by the Department to the National cademy and a report may soon be expected. Should it be favorable, beg to recommend that a special application be made to Congress, as funds ought to be available by February 1, 1886, at the latest.

MISCELLANEOUS.

During the year the names of 1,408 visitors have been recorded, and 137 permits were issued for night visitors, for whose accommodation e small equatorial is set apart. The presence of these visitors is not red to interfere with the regular work of the institution, and perare only issued for one evening in each week, with exceptional ines.

he records kept by the several observers and watchmen show that about one night in eight is good for observing, while an exceptiond night for astronomical work cannot be reckoned upon much than once a month.

The status of the assistant astronomers at the Observatory is a very unsatisfactory one. Their duties demand a high degree of scien ability and long training, and their services grow more and more valua with increase of time. Nevertheless, not only is there nc provision w increase of pay, but their positions have never been assured, but hav depended from year to year on the chance of an appropriation. As a consequence, they have generally soon resigned to accept more lucrativ positions elsewhere, mostly directorships of observatories, or profe ships of astronomy in colleges and universities. Thus this Observatory loses their services when they have become the most valuable. In the twenty-four years that the assistant astronomers have been at this institution, there have been from the corps of three, eleven resigna and only four promotions, and of the latter only one in the last twenty years, facts which speak for themselves. It is respectfully urged that the Observatory should be able to offer sufficient inducements to secure the continued services of its trained assistants; and to that end I beg to recommend that they be recognized by statute as permanent attachés of the institution, with suitable and timely provision for longevity pay. The pay these gentlemen are now receiving is not an adequate compensation for the attainments they bring to their work, nor for the diligent and valuable service they render.

The position and responsibilities of the instrument-maker are of a peculiar and exacting character. Upon him depend the adjustment and the keeping in repair and good working order of all the instruments in use at the Observatory, and it is needless to add that the demands upon his time and attention are constant and unremitting. It is therefore urged that Congress may consider favorably the increase of pay asked for in his case.

In accordance with the recommendations contained in the last report a number of sextants, old and new, have been sent here by the Bureau for examination and report. Ensign A. G. Winterhalter is in charge of this work, and it is to be hoped that the system will not be again abandoned.

TRANSIT OF VENUS, DECEMBER 6, 1882.

The work of reducing the various observations of this transit has been carried on through the year under the immediate supervision of Prof. William Harkness, U. S. N., assisted by Messrs. Joseph A. Rogers, A. S. Flint, and Asaph Hall, jr. The details of this work will be found in the appended report of Professor Harkness.

Some $30,000 worth of instruments belonging to the Transit of Venus Commission are stored here, and as they will not again be required by the Commission, I recommend that they be turned over to the Observatory for such uses as the Superintendent may judge best.

Very respectfully,

GEO. E. BELKNAP,
Commodore U. S. N., Superintendent.

Capt. J. G. WALKER, U. S. N.,
Chief of Bureau of Navig
Navy Depart

UNITED STATES NAVAL OBSERVATORY,
Washington, October 3, 1885.

SIR: I have the honor to submit the following report of the work done during the past year, under my supervision, for the Transit of Venus Commission.

The assistants engaged upon the work at the beginning of the year were Messrs. A. S. Flint and A. Hall, jr. Very fortunately an opportunity presented itself last winter of temporarily securing the services of Mr. Joseph A. Rogers to finish the photographic investigations which he left incomplete when he resigned on March 1, 1883. He was re-employed on December 16, 1884. Mr. Hall resigned his position on September 15, 1885, to accept a place in the observatory of Yale College. His loss is a matter of regret to the Commission, especially at this time, when the computations upon which he was engaged are nearing completion. Messrs Rogers and Flint are still in the employ of the Commission.

At the date of my last annual report experiments were in progress to determine whether or not the heliostat mirrors undergo any change of curvature when exposed to the sun's rays. As that question is of vital importance in the theory of the horizontal photo-heliograph, it was thought desirable to make the experiments both in the heat of summer and in the cold of winter. The work was done principally by Messrs. Flint and Hall, and was completed on February 23, 1885. Owing to press of other matters the discussion of the results has not yet been undertaken.

Mr. Rogers is now engaged in writing an account both of the processes employed in preparing and developing the dry collodion emulsion plates used with the photo-heliographs in observing the transit of Venus in December, 1882, and of the experiments which were executed to determine the best method of making pyroxyline for that purpose. Whenever photographs are required which must sustain the test of accurate measurement, the collodion emulsion process offers advantages so great that every effort should be put forth to increase its general availability. Some of our recent experiments incidentally tend in that direction, and although primarily made to clear up obscure points relating to the transit of Venus work, it is hoped they will facilitate the application of collodion emulsion in future operations requiring the use of photo-heliographs. In these experiments pyroxyline has been made from flax, jute, etc., as well as from cotton, which is the form of cellulose commonly preferred.

It will be remembered that wet bromo-iodide plates, made by the bath process, were used with the photo-heliographs in observing the transit of Venus in December, 1874, and the question naturally arises whether or not the negatives then obtained are strictly comparable with those made upon dry collodion emulsion during the transit of December, 1882. For the definitive settlement of that point recourse was had to photographs of the solar spectrum. In June, 1881, a set of such photographs was made upon wet bromo-iodide bath plates of the kind used in December, 1874, and similar sets are now being made with emulsions ly as possible in the same condition with respect to age, etc., as ually employed in observing the transit of December, 1882. In ow clearly the progressive action of the solar rays upon the each set begins with the shortest exposure capable of pro- easily legible impression, and extends to exposures two or d times as great. The negatives have not yet been sub- cal examination, but the general result seems to be that,

while marked differences exist in the action of the spectrum upon the two classes of plates with the exposures given in the photo-heliogra the effective rays are of substantially the same wave-length in The transit plates of 1874 and 1882 are therefore quite comparable in this respect, and there is no reason to apprehend systematic differe between them depending upon atmospheric dispersion. The spect photographs have also established the fact that the emulsion plates a degree of sensitiveness not very different from that of bath wet plate.

Since the end of February, 1885, Messrs. Flint and Hall have bee engaged pretty steadily in reducing the observations for time and tude made at the various United States stations in December, These computations are now nearly completed, and to a consider extent prepared for printing. It is expected that they will form Par III of the Transit of Venus Reports. No progress has been made in the reduction of the photographs during the current year, and it is not proposed to take them up again until after all the manuscript rela to time, latitude, and longitude has been prepared for the printer.

The work of printing Part II of the Transit of Venus Reports has recently been resumed, and will probably be completed at an early date. This part will form a volume of about five hundred quarto pages, will contain the records of all observations made at the United Sta stations for observing the transit of 1874, together with the corresp ing reductions and discussions, excepting only those relating to photographs.

Very respectfully, &c.,

WM. HARKNESS,
Professor of Mathematics, U. S. Navy, of Executive Committee, U. S. Transit of Venus Commission.

Prof. ASAPH HALL, U. S. N.,
President of Transit of Venus Commission.

Respectfully forwarded to the Superintendent of the Naval Observatory.

ASAPH HALL,
Professor of Mathematics, U. S. N., President of Transit of Venus Commission.

UNITED STATES NAVAL OBSERVATORY,
Washington, September 18, 1885.

SIR: No appropriation having yet been made for the erection of a new Naval Observatory upon the site purchased therefor under the act approved February 4, 1880, I have the honor to renew the estimate which was submitted by my predecessors in 1882, 1883, and 1884, and beg to request that it may be again submitted to Congress with the approval of the Department.

In anticipation of removal to the new site no money of any moment has been expended at the present location for repairs and improvements for several years. As a consequence thereof the buildings and appurtenances are fast getting into a dilapidated condition, hardly creditable to a national institution of such prominence and character; and unless Congress, in its wisdom, see fit to grant the money, or a part of it, submitted in the estimate for the proposed new structures, then it is urged that a reasonable sum be appropriated f the purpose of improving the condition of things h at the old

The sum required for the new Observatory ($586,138) is intended to cover all expenses of putting the establishment, on its removal, in perfect working condition in every way. It includes the erection of the Observatory buildings proper, quarters for the Superintendent, the observers, and others whose attendance is necessary at all times, especially during the night; the removal and remounting of the instruments, construction of roads, grading and fencing, and other details of like character.

Plans for the proposed building were prepared in 1881, under the ervision of the then Superintendent, the late Rear-Admiral John ers, U. S. N. After completion they were submitted to some ue leading scientists of the country for examination, and, receiving ir approval, were adopted by the Commission authorized by Congress e cognizance of the matter. They are believed to be, in the main, u is desirable.

Tue present location is unhealthy in the extreme, and those who are ed upon for night service suffer more or less from malaria a good part time. Fogs, also, gathering over the Potomac at certain seasons ne year, frequently obstruct the observers, and many desired oppor- for astronomical work are lost in consequence. On the other the terrene surroundings and influences and atmospheric con- the new site are very salubrious and favorable, and it is to be eu u Congress will give such facts careful consideration when the te in question is laid before it.

I also submit, in connection with this subject, a communication from e Supervising Architect of the Treasury to the Committee on Ap- ions of the House of Representatives in 1882.

Very respectfully,

GEO. E. BELKNAP,
Commodore, U. S. N., Superintendent.

Capt. J. G. WALKER, U. S. N.,
Chief of Bureau of Navigation, Navy Department.

TREASURY DEPARTMENT,
OFFICE OF THE SUPERVISING ARCHITECT,
April 22, 1882.

SIR: In compliance with the request of your committee, conveyed by ter of the 12th instant, I have examined the plans and specifications the proposed building for the Naval Observatory.

The present buildings are old and dilapidated, and the interests of the lic service require that the new building should be erected as speedily possible.

I estimate that the lowest amount that would reasonably serve for the year's work would be about one-half of the amount proposed to be ropriated, say, $275,000.

I think, however, the Government interests would best be served by an opriation of the entire amount estimated for the work.

Very respectfully,

J. G. HILL,
Supervising Architect.

FRANK HISCOCK,
Chairman Committee on Appropriations,
House of Representatives.

REPORT OF SUPERINTENDENT NAUTICAL ALMANAC.

NAUTICAL ALMANAC OFFICE, NAVY DEPARTMENT,
Washington, D. C., October 10, 1885.

SIR: I have the honor to submit the following report of the work of this Office during the past year:

The American Nautical Almanac for the year 1888 was issued fi the press in February, 1885, and the large Ephemeris for the same y in May, 1885.

The Atlantic Coaster's Nautical Almanac for the year 1886 is now in press, and is expected to be ready by the middle of the present h. The Pacific Coaster's Nautical Almanac for the year 1885 was eu December, 1884, and the corresponding publication for 1886 was during the last month.

Of the Almanac and Ephemeris for the year 1889, 284 pages are type. This includes the whole of the American Nautical Almanac that year, except the maps and introductory pages.

The computations for subsequent years make their regular pr Those for the year 1889 are nearly complete, and those for 1 , 1891 are in course of execution.

SALE AND DISTRIBUTION.

During the fiscal year 1885 the sale and distribution of publicati was as shown in the following table:

Publications.	Sold.	Distributed.
American Ephemeris	470	83
American Nautical Almanac	1,647	36
Atlantic Coaster's Nautical Almanac	993	153
Pacific Coaster's Nautical Almanac	225	None.

In the year 1882 copies of Volume I of the Astronomical Papers were sent to Gauthiers Villars, Paris, and William Engelmann, Leipsic, for sale by them as agents on the same terms as the sales of publications in this country. Mr. Engelmann has recently reported ten copies as sold, but no returns have been received from the Paris agent.

METHODS OF SELLING ALMANACS TO NAVIGATORS.

In connection with the work of this Office the subject which quires the attention of the Department is the method of supplying vi- gators with nautical publications. On the plan now in ope: i e office which prepares and issues the publications is also cha au their sale, which is effected through agencies ri of the Union. In the case of th e, th plicity of accounts and car

thus arising is disproportionate to the amount realized from sales. As the various offices sell their publications through nearly the same agencies and, it is believed, on the same terms, economy and efficiency ould be promoted by conducting all this business through a single gency.

I therefore beg leave to suggest to the Bureau the advisability of establishing an office or depot in the city of New York for the sale of all the nautical publications of the Navy Department, hoping that other Departments selling such publications would join in the system. Were such a depot established all publications designed for sale would be immediately dispatched to it, and the individual offices would be called on to respond only to requisitions from the depot.

THE COASTER'S NAUTICAL ALMANACS.

In my annual report of 1883 I set forth the evil rising from the multiplicity of nautical almanacs compiled from the Government publications and issued by dealers, not so much to make a profit on the sale to advertise their business. Correspondence with the leading dealers owed, with a single exception, a willingness on the part of each to give up his own nautical almanac and accept a similar publication by the Government, provided all the other dealers would adopt the same course. The firm of John Bliss & Co., of New York, was the only one t objected to the proposed policy. As their objections did not seem rong enough to justify a change in the general policy of the Government during the past fifteen years of furnishing American navigators th all the nautical publications necessary for their use, the Coaster's almanac was issued as an experiment in March, 1884. It was received with such strong expressions of favor and such assurance of large sales every direction that no doubt was entertained of its coming into universal use. The hope that such would be the case has not, however, been verified, the principal reason being that the lack of unanimty among the dealers has resulted in a continuance of their almanacs, hich are now sold at a nominal price, or issued gratuitously for advertising purposes.

ASTRONOMICAL RESEARCHES.

On assuming charge of this Office, in the year 1877, one of the first features of the work which struck the Superintendent was the fragmentary character of the astronomical tables used in preparing the Ephemeris. The only modern tables in use abroad were those of Le Verrier, and these were so far from meeting the present requirements of exact astronomy that it was deemed best to undertake the construction of new ones, which should correspond in every respect to the present refinements of astronomical observations. The results first necessary are accurate determinations of the elements and masses of the eight large planets. These require the re-reduction of the planetary observations made in the principal observatories of the world since 1750, and their comparison with Le Verrier's tables. This work at first went on very slowly, the means for prosecuting it being gained rather by economizing in other office expenses than by asking for larger appropriations.

This work has now reached a point at which its end can be foreseen. With the present appropriations the necessary computations may be x pleted in about four or five years. The results will, it is hoped, serve i the purposes of astronomy until at least the middle of the coming

century, and perhaps until its close. They will also enable a large permanent reduction in the cost of preparing the ephemeris to be made.

The investigations required for this work are published in a series under the title of Astronomical Papers of the American Ephemeris. The first volume of these papers was completed in the year 1883, and Volumes II and III are now being issued in parts as different publications are ready. Two parts have been stereotyped since my last annual report, namely:

Volume II, Part III, Measurements of the Velocity of Light, by the Superintendent and Professor Michelson.

Volume III, Part IV, On the Inequalities in the Moon's Mot computed by Mr. Neison, by George W. Hill, assistant, Nautical Almanac.

The stereotyping of both these parts was completed some mo since, but, through some unexplained delay in the Government Printing Office, neither has yet been issued.

In the yet unpublished computations progress has been made follows:

Theory of Jupiter and Saturn.—Mr. Hill's work on the perturbati of these two planets was completed during the past summer. I have reason to believe that its value and durability will be more than proportional to the labor spent upon it.

Mass of Jupiter.—The work of computing the perturbations of Polyhymnia by Jupiter and the other planets, the commencement of which was reported last year, has been carried from the discovery of the asteroid in 1854 up to the opposition of 1888. It was carried so far forward because of the very near approach of the asteroid to Jupiter in 1885, the effect of which will be measured by observations when the planet reaches its perihelion in May, 1888. The work was done so far in advance because an opportunity was found for having it executed by a remarkably skilled mathematician, Prof. G. C. Comstock.

General perturbations of the four inner planets.—This work is being carried on in duplicate by Messrs. Prentiss and Corrigan, but owing to the unexpected labor encountered in certain operations of it, it is still incomplete.

Comparisons with observations.—The re-reduction of Maskelyne's Greenwich observations, from 1765 to 1811, has been prosecuted during the year, and is approaching completion. An ephemeris of the sun from 1765 to 1864 is also approaching completion, it being found more economical to compute a complete ephemeris than to determine the numbers by piece-meal for the separate observations. Preparations are being made for going on with the tabular computations upon Mercury, Venus, and Mars for the same period, a work which was interrupted in order to finish the solar ephemeris. This is now the heaviest part of the whole work which remains to be done.

Very respectfully, your obedient servant,

SIMON NEWCOMB,
Superintendent Nautical Almanac Office.

Commodore J. G. WALKER, U. S. N.,
Chief of Bureau of Navigation, Navy De

REPORT OF HYDROGRAPHER.

UNITED STATES HYDROGRAPHIC OFFICE,
BUREAU OF NAVIGATION, NAVY DEPARTMENT,
Washington, D. C., October 1, 1885.

SIR: I have the honor to submit the following account of the operations of this Office for the fiscal year ending June 30, 1885:

As this is the only establishment on this continent where charts of foreign waters are made, I have thought it appropriate also to make further recommendations as to its development and usefulness, so that it may be put on a footing commensurate with its importance.

In order to give a more comprehensive idea of the work performed, different divisions of the office are referred to separately, while detailed statement of the head of each division will be found in the ıdix.

DIVISION OF CHART CONSTRUCTION.

This Division, described in the last annual report as the Drafting and ıngraving Division, was moved in July to a small building on the corner New York avenue and Seventeenth street. The Division of Plates Printing was also transferred to the same building, to be coned later on with the first named, the two constituting what is now n as the Division of Chart Construction. The building now occu- entirely unfitted for the purpose. Draftsmen and engravers ıu be surrounded by the most favorable conditions of light, ven- tion, dryness of atmosphere and apparel, and freedom from vibra- The building in question has none of these qualifications, and is uently a serious drawback to the execution of good work. A reat deal of time is necessarily wasted in passing to and from this Divi- ınd the main Office, where the plates are stored, and the wear and the plates that have to be transported back and forth is consid- le. This separation of parts of the office which are so dependent ach other has been a great disadvantage.

A new press has been added, which has greatly facilitated the opera- of printing, and enabled the Office to fill orders which had been ulating for some time.

Under the active supervision of an officer detailed for the purpose, ything that pertains to the printing of charts shows a very marked ovement on the work of previous years.

A great deal of time has been devoted to preparing plates for electro- and in removing defects resulting therefrom.

The process of electrotyping the copper plates has been continued,) altos and fifty one bassos having been completed.

office should not be dependent on outside parties for this process, en is so necessary for the preservation of the plates. The cost of ortation to and from the electrotyping establishment in New York rge, and the risk of damage is very great to expensive plates. This l be avoided by having the proper apparatus in this Division. The of the process, taking into consideration the first outlay, would be less than under the present system.

Much of the energy of this Division has been devoted to the c tion of charts, and during the year nearly every plate in the undergone alteration.

A series of great circle charts covering the navigable waters of globe has been devised by Mr. G. Herrle, chief draftsman. The putations are all finished, and one of the plates, in the hands of graver, is well advanced. It is thought that these charts will be of great advantage to seamen taking long voyages, as the methods required for their use are of the simplest description.

A great circle protractor for the solution of problems in nautical tronomy, designed by Commander Sigsbee, U. S. Navy, is nearly engraved. A thorough investigation into the subject of geographical positions has been carried on, and the record resulting has been of g service in the compilation of new charts. This is now the Hydrogra Office standard for all determinations of latitude and longitude. A similar investigation into the subject of magnetic variation has been made for a like purpose with very important results.

The changes in the method referred to in the last annual report were made in the early part of the year and have been productive of the results. Under the old system nearly the whole force was employed the correction of old charts, latterly 75 per cent. of the energy of the Division has been available for the production of new ones. The detailed account of these new methods will be found interesting.

A complete history of the charts already in existence at the beginning of the year has been practically finished, and this record is now kept correct.

Special attention has been paid to the improvement of chart-making in the endeavor to keep this science abreast of the march of progress.

For such portions as can be subjected to rule, standards have been devised and adopted in order to have as little diversity as possible in the construction of different charts. Shore-lines have been made more conspicuous and the topography drawn with special reference to its value as an aid to navigation. In this connection an investigation has been made into all the methods of delineating irregularities of the surface of the earth, and, as a result, it has been decided to use contour lines for hills, with roulette shading on all large scale charts. Rules have been established with regard to lettering, the object being to secure uniformity and remove from that portion of the chart used by the navigator all unnecessary matter.

The change proposed in the compass has been made, and charts embodying the degree graduations on a true compass have been submitted to the maritime bodies of the sea-board cities through the Branch Offices, and to as many sea-faring men as possible with the almost universal verdict in its favor.

Many other changes have been made which are the result of careful study of the science of chart-making and a proper comprehension of the needs of seamen. For the detailed account of these changes, as well as of the various operations of this Division, I call special attention to the very comprehensive report of the officer in charge, to whose zeal and intelligence these improvements are largely due.

DIVISION OF SUPPLY.

This Division being the depository for the charts published by this Office, as well as for those received from the Coast and Geodetic Survey to be issued to our vessels, and being the real depot where the agents'

orders for charts are filled, its name was changed from Chart Division, as given in my report of last year, to Division of Supply.

The labor of keeping the stock of engraved charts corrected by hand for the small errors which are constantly reported has engrossed the energies of the force employed in this Division. This has interfered with the work of comparing old photolithographs on hand with later editions of charts of the same localities issued by other nations, and consequently the number of canceled lithographs is less than was anticipated. The increased number supplied to ships of war is due to the unusual number of engraved charts published during the year, while the greater number supplied to agents is a most gratifying proof of the growing estimation in which our charts are held by the merchant marine. The total number of copies issued, 24,725, though apparently less than that of the preceding year, 26,179, is accounted for by the fact that the outfits for the Branch Offices were comprised in the latter number. The increase in the number of copies issued to merchant vessels carrying meteorological journals is satisfactory evidence of the greater interest on the part of merchant captains in the meteorological work of the Office, each new observer being furnished with a set of general sailing charts. This also affords further proof of the growth of the popularity of our publications.

A set of index charts was designed in this Division during the year, and the investigation into the authenticity of reported dangers has been continued.

DIVISION OF ISSUE.

The duty of issuing to all United States vessels which receive charts from this Office, having been assigned to the Admiralty Chart Division, its name was changed to Division of Issue. As the publications of the British Admiralty form the greatest portion of the chart outfits of ships of war, it was thought best to hold this Division responsible not only for the original supply, but also for its continuance during remainder of commission.

This work, which requires the most constant attention, owing to its great importance, has been exceedingly well performed. The labor of keeping a record of the charts on board ship has been greatly facilitated by the new chart lists referred to in the last annual report, in the paragraph concerning the Admiralty Chart Division.

These catalogues have been completed and issued to all ships in commission. Navigators everywhere have received them most favorably, and they have proved of great assistance in the handling and keeping account of the chart outfit under the various conditions incident to ips in active service.

The examination of the old stock of British Admiralty Charts has been pleted and those now on the shelves are of the latest editions. The mber of copies has been reduced to the lowest limit considered adable in view of any contingencies which might arise. The practice ordering the latest edition of publications from London direct to ships ar has been continued throughout the year with most satisfactory esults.

DIVISION OF BOOKS.

The work of cataloguing and arranging the books and pamphlets in r that they may be most available for the purposes of the office has commenced. It is intended to brief the contents of all publica- relating to hydrography. These abstracts, arranged alphabeti-

cally, will give references to data concerning the particular sub under discussion.

The number of books of reference has been increased, and lists been prepared to show what books are still needed in order to this collection more valuable. The appearance of new editions of ing directions has been carefully noted, and the same system of order direct to the ships from London that is practiced by the Div a Issue has been adopted.

Of the ninety-nine different books of sailing directions issued to ships, fifty-eight are English publications; the suggestion of the h of this Division, therefore, is most pertinent, that the Hydrographic should prepare a complete set of sailing directions for all parts of globe in order to be independent of foreign publications.

In addition to other duties, the force of this Division has been e in compiling a supplement to the "Newfoundland and Labrador ... and in comparing the different publications issued by the Office in to prevent unnecessary repetition. It has been found that the matter frequently appears in different books, and in order to li the labors of the navigator and to economize his space it is the in tion to consolidate and, if possible, avoid duplication.

Particular attention is called to the report of the head of this Division, whose suggestions I most heartily indorse.

DIVISION OF NOTICES.

The acquisition of a cylinder press in the printing room attached to the Navy Department has greatly facilitated the issue of Notices to Mariners. In order to make these useful publications compare favorably in appearance with those of a similar nature issued by foreign governments, and at the same time to lessen the expense of postage, they have been printed upon a very fine and light quality of paper.

The demand for these Notices has steadily increased, and their distribution has been the means of obtaining for the Office an increased amount of information from the merchant marine.

To extend their usefulness still further it was thought advisable to issue a weekly edition, which is kept on file in all the United States consulates and in the offices of the principal English-speaking shipping merchants in all the seaboard cities of the world.

This edition has an alphabetical index of its contents on the first page, so that a shipmaster bound to any portion of the world can tell at a glance whether it contains matter of especial interest to him.

A large number of foreign notices to mariners has been received and all new information has been translated and published.

In accordance with the policy of the office the six volumes of light-lists, including all the light-houses of the world, were revised by the officer in charge of them, with commendable promptness and accuracy, and were ready for publication *and sent to the printer* before the first of July. With the valuable assistance of the officials of the Government Printing Office these were printed immediately and distributed to the agents and ships of war.

The files of foreign charts have been completed so that the office is now in possession of a most valuable collection of original charts issued by other governments, by means of which the examination of all matters pertaining to this branch of hydrography is greatly facilitated.

The securing and classification of original papers relating to surveys and to matters pertaining to hydrography in general, outside of books

and pamphlets, has been carried on throughout the year, and at the same time a card catalogue has been completed which greatly simplifies the finding of desired documents.

DIVISION OF METEOROLOGY.

Owing to the small force of officers assigned to this Division it has been impossible to continue the publication of meteorological charts covering the South Atlantic and Indian Oceans. The demand for the North Atlantic meteorological charts mentioned in the annual report of last year has increased, and the recommendation of the officer in charge of this Division that the series for the South Atlantic should be prepared at once meets with my hearty approval. With the assistance of a few additional officers, this valuable publication could be got ready in a few months.

The preparation of the Monthly Pilot Chart of the North Atlantic has absorbed most of the attention of this Division, and the demand for it has increased in a very satisfactory degree. The effort to make it useful has been thoroughly appreciated by all seafaring men, and the support and assistance received from this class have been very considerable. The maritime papers and meteorological periodicals have referred to it constantly in flattering terms, and where accidents have occurred, through carelessness in going into the floating ice region, this chart has been quoted to show how such disasters could have been avoided.

The collection of data relative to trade-wind and fog limits, location of water-spouts, to the use of oil for calming the seas during gales of wind, and many other phenomena of interest and value to seamen has been continued assiduously. It is proposed to enlarge this chart so as to admit of certain changes which experience suggests, and to give more space for the reports received from the merchant marine.

A more detailed statement of the work of this division will be found in the appendix.

BRANCH OFFICES.

These useful adjuncts have continued to be of great assistance, not only to the main office, but also to the maritime communities in which they are located. The officers attached to them have been called upon to determine all kinds of nautical questions, and their influence in many instances has been most favorable. The routine established for them last year has been adhered to generally, although their increased efficiency and popularity have rendered some slight changes necessary.

The increase in the demand for charts has been partly due to the Branch Offices, while, to them, the greater number of notices to mariners and monthly pilot charts distributed can be almost entirely ascribed. Their principal function, however, is the collection of data, and the dissemination of useful information of all kinds to the merchant marine. The amount of work done in boarding vessels, correcting charts, adjusting barometers, etc., will be found detailed in the appendix.

The following comparison is made with a portion of the work of last year:

	1883-'84.	1884-'85.
Vessels boarded	4,256	11,750
Number of individuals to whom nautical information was given, not included in the preceding	2,286	10,870
Barometers corrected or compared	2,062	5,343

Fifteen thousand six hundred and fifty three Pilot Charts and 16,8[illegible] Notices to Mariners have been distributed during the year. It [illegible] conceded that this is a very thorough demonstration of the us[illegible] these offices. Without them it is fair to suppose that most of the [illegible] men who have received information would have done without it, and [illegible]sequently run greater risks. The collection of nautical information [illegible] its consequent dissemination from an authentic source must go a [illegible] ways toward decreasing the dangers of navigation, while it pr[illegible] the education of seamen and elevates the dignity of their profession.

The offices at Philadelphia, Baltimore, New Orleans, and [illegible] Fran[illegible]cisco have increased their sphere of usefulness by controlling [illegible] erected by the Hydrographic Office. On the maritime exchanges of those cities the first three receive their time directly from the Nati[illegible] Observatory at Washington, while the last gets the time from [illegible] branch observatory recently established at Mare Island. These [illegible] have been of great assistance to seamen in rating chronometers. [illegible] Branch Offices are invaluable, and should be maintained on a lib[illegible] footing.

GENERAL RECOMMENDATIONS.

In order to carry on the constantly expanding work of the Office [illegible] most economy to the Government, its various divisions, with one ex-ception, should be in the same building. Owing to the disagre[illegible] odor arising from the benzine used in printing, this sub-division of [illegible] Construction should not be placed in the same building with other work, but should be close to it and ventilated in such a manner that it may not be a public nuisance.

The working of the heavy presses jars the building in which they are placed so that at times it is impossible for engravers to work. As the copper plates are constantly required by the engravers, and must be stored in some safe place, and as any transportation is sure to scratch them more or less, it will be seen that the printing should be done in a specially constructed building very close to the main building. The latter should be designed with special reference to light, ventila-tion, and freedom from vibration in order that the best results may be obtained from the draftsmen and engravers. It should be sufficiently large to contain the whole working force and material of the Office, so that little time need be wasted in going between rooms where different documents are kept for reference.

It is recommended that Congress be asked to make an appropriation for a building which will be suitable for the needs of the Office.

In regard to the policy which should regulate the construction of charts, a careful study has demonstrated that the following should pre-vail:

In general the function of this Office should be the production of cheap and accurate charts, made especially with reference to the wants of a majority of the people who use them, and these should be taken up in the following order:

(1) The publication of the results of original surveys made by Ameri-can officers.

(2) The republication in whole or in part, on a scale to be determined by the Office, of foreign surveys not republished by the British Admiralty, and which will be of service to American commerce. This republication should not be confined necessarily to the limits of the originals, but

ıould serve only as data from which to construct new charts suited to he needs of American navigators.

(3) New charts should be compiled from those of the British Admiralty, hich are always good repositories of data. These should have proporions, scales, and a general comprehensiveness of detail suited to the eculiar needs of American commerce of which it is the province of this ffice to keep informed.

(4) By adhering closely to the policy suggested in the preceding paragraphs the time will arrive shortly when the final effort should be made o become wholly independent.

To be ready for any emergency, it will then be advisable to fill out all even though some localities not frequented by Americans may covered. The Government will thus possess a set of charts covering vigable waters of the globe. In furtherance of this plan, sets of s for the West Indies, the north coast of South America, and the ity of Newfoundland have been outlined and are well advanced, enough money should be asked of Congress to complete them imiately. The only work which should take precedence of this is that formed by the Ranger on the west coast of Central America during last season.

It must be borne in mind that it is for the interest of the maritime munities, entirely independent of such a contingency as war, that Government should possess the means of producing correct charts l times. The navigators of the Navy are practically dependent to on Admiralty charts, which form 85% of the chart outfit of a ship of cruising on the European station, 70% on the Asiatic, 30% on the ific, 40% on the South Atlantic, and even 25% on the North Atlantic home station. These numbers do not represent the large proportion of ign charts used by the merchant marine, as the vessels of the Navy e obliged to take many publications which the merchant vessels do need. If these foreign charts were always the best, the question ould present no difficulty from a commercial point of view, but owing to the changes which are being constantly made, it is impossible for gents in this country to keep a supply of the latest editions of charts ade in England. As a matter of fact, the agent buys his supply, and, cept in special cases, keeps it on his shelves until sold, no matter many new editions may have appeared in the mean time. It is of frequent occurrence also that a chart needed cannot be found in this country, and the owners must take the risk of sending their vessel without or wait until one can be sent from England. As a consequence captains go to sea constantly from American ports without a proper supply, or with charts which have been condemned in England, and which, in many cases, expose them to most serious risks. It is obvious, then, that the Government should possess a complete set of copper plates and be prepared at all times to furnish the maritime community with the most accurate charts at short notice.

In the contingency of war, which would interfere with our supply, the copies of Admiralty charts always kept in this office would serve as models for photolithographs, which could be used in an emergency, but which would speedily become valueless as the number of corrections increase. Each copy of photolithographs has to be corrected by hand, while with engraved charts the plate from which the copies are taken is corrected. The Government is in no position to supply the deficiency, as the making of copper-plate engravings is a slow process.

All other nations of any importance are entirely independent in this respect. In view of any possible contingencies, it is recommended that

a set of charts connecting Lake Ontario with the ocean should be made at once. A plan for their construction has been elaborated in this Office, and in view of the fact that our only source of supply is the British Admiralty, it is very important that Congress be asked to make a special appropriation for this purpose.

The recommendations of previous years in regard to new surveys of the north coast of South America are of more force than ever, as will be seen in the report of the head of the Division of Chart Construction.

The attempt has been made to compile a set of new charts of the coast from Panama to Cayenne, and the result has been most unsatisfactory. About all that is known accurately is that existing charts are wrong. The Thetis should be sent there this winter to make a thorough survey, commencing at Aspinwall and working east.

The existence of the numerous reported dangers in the North Pacific should be determined at once by deep-sea soundings, and in this connection I wish to reiterate my recommendations of last year that every vessel of the Navy be provided with a deep-sea sounding apparatus and be required to sound at distances of at least 20 miles when there is no urgent necessity for a quick passage. Little time is necessary to take soundings in great depths, and an examination of any locality where a danger is supposed to exist can be very quickly made.

More data is necessary in regard to ocean temperatures. A ship should be fitted out expressly to make proper investigations into this subject and thus aid in the solution of the problem of ocean currents. Such a vessel could also carry on experiments to determine the laws of wave motion, which would be of great importance to the naval architect.

It gives me great satisfaction to state to the Bureau that I have received the most gratifying assistance and support from all the officers and employés attached to this Office. The interest taken in its reorganization and the cheerful performance of such a variety of duties as the necessities of the Office have often demanded, have been most noticeable.

The thanks of the Office are due particularly to the Department of State, the Coast and Geodetic Survey, the Light-House Board, the Government Printing Office, and to all foreign hydrographic offices and marine boards. Special thanks are also due to the different maritime bodies and the press of our seaboard cities.

Respectfully,

J. R. BARTLETT,
Commander U. S. N., and Hydrographer.

HYDROGRAPHIC OFFICE, UNITED STATES NAVY,
BUREAU OF NAVIGATION, NAVY DEPARTMENT,
Washington, D. C., September 29, 1885.

SIR: In obedience to the order of the Department for a statement in accordance with section 3664 of the Revised Statutes, to accompany the estimates of the Hydrographic Office, for contingent and miscellaneous expenses, showing the necessity or importance of an increase of $24,600 over the sum appropriated for that purpose for the current fiscal year, I have the honor to submit as follows:

The necessities of the Office as now reorganized, with its branches in the maritime cities, and a decided policy chosen, that of advancing the

:ime interests of the country, require that the estimates should be ased from those of last fiscal year.

e purchase of charts and sailing directions furnished to our ships ır is a large item of expense to this Office, if the vessels are kept lied as at present with only the latest editions; for the coming fis- ear at least $7,000 will be needed in anticipation of fitting out ad- nal vessels. The expense incurred during the last fiscal year was)0.

e electrotyping of the engraved copper plates belonging to the should be continued in order to save them. About one-fifth of the s have now been electrotyped, but under the present appropriation ork must be deferred. At least $5,000 will be needed for this pur-

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r continuing the series of charts of the West Indies and around h America, $10,000. The balance of the increase is for the various oses named in the estimates, all of which require a larger amount e Office is to be kept at its present standard.

e estimate for the Branch Offices has been increased by $2,000. Up e present time an enlisted man has been at each office; but these ng been taken away, it will be necessary to employ an assistant senger at $720 for each of the six offices.

lditional quarters should be rented for the printing and engraving, the estimate is therefore increased $300.

1874 the appropriation for this Office was $109,800; for the present it is $74,040. The work of the Office is steadily expanding, and ap- riations should be made commensurate with its work and useful-

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necessities and sphere of this Office are given in detail in my ıal report to the Bureau.

e estimate for the civil establishment of the Office has been in- sed from two clerks of class two and one clerk of class one, to one of class four, one of class three, one of class two, and one of class an increase of one clerk of class four, and $200 for one clerk from s two to class three.

is clerical force will only be commensurate with the work actua ssary to be performed. The correspondence with foreign offices, uls, the commanders of our ships of war, and the merchant marine, branch offices, merchants, and those interested in nautical matters; the agents for the sale of charts, and keeping the accounts of the e, has increased, and with the present force cannot be properly done.

e present force of engravers should be increased by two additional, rder that as much work as possible should be done in the Office un- immediate supervision.

e drafting, engraving, and printing of the Office is now performed rented building, but there is no watchman allowed to care for it out fice hours. It contains very valuable property, and a watchman ıld be allowed.

Very respectfully,

J. R. BARTLETT,
Commander, U. S. N., and Hydrographer.

ommodore J. G. WALKER, U. S. N.,
Chief of the Bureau of Navigation.

DIVISION OF CHART CONSTRUCTION,
Hydrographic Office, July 1, 1

SIR: I have the honor to submit the following report of this Di for the year ending June 30, 1885.

The Drafting and Engraving and Plate and Printing Division consolidated near the end of the year under the title of the Divi Chart Construction. The reports, however, are made separatel that of the officer in charge of plates and printing is appended a plementary. At the time of the last annual report these Division in the State, War, and Navy Department building, but were mo July, 1884, to rented quarters at the corner of New York avenu Seventeenth street.

CONSTRUCTION OF NEW CHARTS.

The following table shows the work done on new charts duri year. It also gives the condition of all unfinished charts.

Much attention has been paid to the construction of new cha being deemed better to devote more time to the engraving o plates, of which the Office is in great need, and less to the maki corrections on the old ones now in the Office.

Record of work done on new charts in Division of Chart Construction during the ye ing June 30, 1885.

Chart No.	Name.	When begun.	When finished.	Remarks.
950	St. Nicolas Mole, Haiti	June, 1884	Mar., 1885	Engraved.
951	Jacmel Harbor, Haiti	June, 1884	Jan., 1885	Do.
914	Santo Domingo Harbor, Haiti	Aug., 1884	May, 1885	Do.
935	Chacahua Bay, Mexico	Sept., 1884	Jan., 1885	Do.
937	Corinto Harbor, Mexico	Aug., 1884	May, 1885	Do.
939	La Libertad Harbor, Central America.	Sept., 1884	Feb., 1885	Do.
394	Caribbean Sea, western part	Jan., 1883	Sept., 1884	Do.
158	Port Jururu, Cuba	May, 1883	Oct., 1884	Do.
159	Port Bita, Cuba	May, 1883	Nov., 1884	Do.
160	Port Nipe, Cuba	May, 1883	Nov., 1884	Do.
161	P. Cabonico and Livisa, Cuba	Apr., 1883	Nov., 1884	Do.
796	China Sea, Sheet I	Oct., 1882	June, 1885	Do.
797	China Sea, Sheet II	Jan., 1883	June, 1885	Do.
798	China Sea, Sheet III	Dec., 1882	June, 1885	Do.
799	China Sea, Sheet IV	Jan., 1882	June, 1885	Do.
933	West coast of Mexico	Sept., 1882	Nov., 1884	Do.
932	.... do	Sept., 1882	July, 1885	Engraved, now in hands o typer.
446	Magellan Straits, Sheet I	Feb., 1883	May, 1885	Engraved.
446a	Magellan Straits, Sheet II	Feb., 1883	May, 1885	Do.
447	Magellan Straits, Sheet III	Feb., 1883	Apr., 1885	Do.
447a	Magellan Straits, Sheet IV	Feb., 1883	Apr., 1885	Do.
925	Savanilla Harbor, Colombia	Dec., 1883	June, 1885	Do.
21	North Atlantic Ocean, Sheet I	1876	Dec., 1884	Do.
21a	North Atlantic Ocean, Sheet I	1876	Dec., 1884	Do.
22	North Atlantic Ocean, Sheet II	Oct., 1879	Apr., 1885	Do.
22a	North Atlantic Ocean, Sheet II	Oct., 1879	Apr., 1885	Do.
823	South Pacific Ocean, Sheet I	1872	Jan., 1885	Do.
823a	South Pacific Ocean, Sheet I	1872	Jan., 1885	Do.
824	South Pacific Ocean, Sheet II	1872	....	Do.
824a	South Pacific Ocean, Sheet II	1872	....	Do.
825	South Pacific Ocean, Sheet III	1872	....	Do.
825a	South Pacific Ocean, Sheet III	1872	....	Do.
826	South Pacific Ocean, Sheet IV	1872	July, 1885	Engraved, requires still a f work.
826a	South Pacific Ocean, Sheet IV	1872	July, 1885	Do.
954	Ports on south and west coast of Haiti.	June, 1884	Apr., 1885	Heliograved.
952	Ports on north and west coast of Haiti.	July, 1884	Apr., 1885	Do.
953	Ports on northwest coast of Haiti	Aug., 1884	Jan., 1885	Do.
784	Callao Harbor, Peru	Nov., 1884	Apr., 1885	Do.
135	San Fernando Anchorage, Trinidad	Nov., 1884	June, 1885	Do.

rd of work done on new charts in Division of Chart Construction, &c.—Continued.

	Name.	When begun.	When finished.	Remarks.
	Caye Flamande, Saint Louis and Meste Bays, Haiti.	June, 1884	Mar., 1885	Heliograved.
	Saint John's Harbor	May, 1884	Nov., 1884	Do.
	La Poile Bay	June, 1884	Sept., 1884	Do.
	Bocas de Dragos and Port of Spain, Trinidad	Jan., 1884	July, 1884	Do.
	Port Hamilton	Jan., 1884	July, 1884	Do.
	Louisburg Harbor	Feb., 1884	July, 1884	Do.
	Pistolet Bay	Mar., 1884	Nov., 1884	Do.
	Canada Bay	Jan., 1884	June, 1884	Do.
	Bay of Islands	May, 1883	Oct., 1884	Do.
	Port Basque	Feb., 1884	July, 1884	Do.
	Grand and Lesser Caymans, West Indies	Mar., 1883	Sept., 1884	Do.
	Road Harbor	Jan., 1884	July, 1884	Do.
	Point à Pitre	Apr., 1883	June, 1884	Do.
	Ports in Magellan Straits	Dec., 1883	June, 1884	Do.
	Chart of measured mile	July, 1884	Aug., 1884	Photolithographed.
	Polar regions	Oct., 1884	Feb., 1885	Do.
	Halifax Harbor	June, 1884	Apr., 1885	Heliograved.
	Caribbean Sea, southwest part	Feb., 1883		Nearly finished.
	Port Plata, Haiti	Sept., 1884		Do.
	Tenacatita and Navidad Bays, Mexico.	Oct., 1884		Do.
	Chamela Bay, Mexico	Nov., 1884		Do.
	Nassau Harbor, West Indies	Jan., 1885		Do.
	East coast of United States	Nov., 1883		In hands of lettering engraver.
	do	Sept., 1883		Requires tinting only.
	do	Sept., 1883		Do.
	do	Nov., 1884		Nearly finished.
	East part of Bahama Islands	Nov., 1883		This chart has been withdrawn, 944 being extended to include it.
	West part of Island of Haiti and vicinity.	Nov., 1883		Nearly finished
	Cuba, western part	June, 1884		Ready for engraver.
	Island of Haiti	Dec., 1884		Do.
	Mouth of Amazon River	Jan., 1881		In hands of engravers.
	West coast of Mexico	July, 1883		Do.
	Hong Kong Harbor, China	Apr., 1884		Do.
	Vancouver's Island	July, 1885		Do.
	Port of Vera Cruz Mexico	Feb., 1885		Finished, except engraving of lettering
[illegible]	San Juan del Sur, Central America	Apr., 1885		Nearly finished.
974	San Lorenzo Bay, Central America	Feb., 1885		In hands of engraver.
975	Port of Bahia, Brazil	Feb., 1885		Do.
971	Rio Janeiro Bay, Brazil	Feb., 1885		In hands of heliograver.
972	Rio Janeiro Harbor, Brazil	Feb., 1885		Do.
976	Payta Harbor Peru	Dec., 1884		Do.
977	St Thomas Harbor, West Indies	May, 1885		Do.
965	Virgin Passage West Indies	Jan., 1885		Ready for engraver
966	Northeast coast of Yucatan	Mar., 1885		Do.
969	North coast of Brazil	Feb., 1885		Do.
970	do	Mar., 1885		Do.
973	Gulf of Fonseca	Apr., 1885		Do.
979	Pisco Bay Peru	June, 1885		Do.
978	Cartagena Harbor, Colombia	June, 1885		In hands of draftsman.
980	Entrance to Rio Plata	Aug., 1884		Nearly ready for engraver.
963	Circumpolar Chart	Mar., 1885		Nearly ready for lithographer.
964	North coast of Colombia	Jan., 1885		In hands of draftsman.
961	Newfoundland Banks	May, 1885		Do.
960	Port Barcelona, Spain	Nov., 1884		Withdrawn to await later information
968	North coast of Guyana	Feb., 1885		Suspended to get more reliable data from Dutch Hydrographic Office.
281	Mediterranean, Sheet I	1874		In hands of engraver will be finished about September 30, 1885.
282	Mediterranean, Sheet II	1874		Practically finished, waiting for 281.
283	Mediterranean, Sheet III	1874		Do.
23	South Atlantic Ocean, Sheet I	Dec., 1879		Nothing has been done to these plates, as the ones they are to replace were still serviceable and other work was more important.
23a	do	Dec., 1879		
24	South Atlantic Ocean, Sheet II	Dec., 1880		
24a	do	Dec., 1880		
292	Channels between Baltic and North Seas.	Jan., 1880		Work discontinued in 1882.
[illegible]	North Sea	April, 1879		Work discontinued in 1880.
900	West coast of United States	Jan., 1881		Work discontinued in 1882.
901	do	Jan., 1881		Do.

CORRECTION OF CHARTS.

Much of the work of this Division consists of the necessary correction of charts for all new information which comes to the Hydrographic Office. Nearly every plate has received minor corrections during year, and many have received extensive additions and alterations.

OTHER WORK OF DIVISION.

Forty-three plates have been electrotyped during the year, and much work has been done by the engravers in preparing them for electrotyping and in removing the defects caused by this process.

A series of five great-circle sailing charts has been projected and much work done on them. They are of the North Atlantic, South Atlantic, North Pacific, South Pacific, and Indian Oceans. The one of the North Atlantic is now in the hands of the engraver for the engraving of the projection lines, compasses, border, &c. The computations for all the projections and compasses are completed.

A great-circle protractor, for the solution of problems in great-circle sailing and other problems in nautical astronomy, designed by Commander C. D. Sigsbee, U. S. N., has been laid down on copper and nearly engraved.

Much work has been done in making researches and compilations of latitudes and longitudes, and a method of recording them has been instituted. Already much valuable information has been collected. This record is principally for use in the compilation of new charts, but it will soon become valuable for publication as the adopted positions of this Office, and for correcting previous publications now out of date or incorrect. The form in which these positions are recorded is shown by the following specimen page heading. In the column of remarks a very complete history of the sources, accuracy, and reliability of each position is recorded.

Record of longitudes used in the construction of the charts of the United States Hydrographic Office.

No.	General locality.	Name of place.	Description of observation spot.	Longitude from Greenwich.	Latitude.	Secondary positions upon which the longitudes depend.			Originally established difference of longitude.	Authority.		Remarks.
						Place.	Date.	Longitude.		Name.	Date.	

Attention has been paid to the investigation of magnetic variation. A method of recording all data obtained and all authorities on the subject has been devised, and the work of collecting it commenced.

CHANGES MADE IN ROUTINE OF THE DIVISION DURING THE YEAR.

A method of keeping charts corrected to date was a subject of early attention, and an entirely new system was devised. It has now been in successful operation about a year. Form y y the entire force

was engaged in the correction of charts; since the change at least 75 per cent. has been available for work on new charts

In a general way this saving has been accomplished by a system of book-keeping. All information coming to this Division is first entered in an Information Book. From this it is entered in a Record of the Correction of Plates, wherein it is charged against every chart affected; and when a plate is corrected to date, for all the information against it the changes made are entered in this same book opposite the authority therefor, so that when any chart is to be corrected a complete history of all previous corrections and a complete list of those necessary to be made is at hand. This saves all duplication of work or comparison, and collection of data, thus greatly decreasing the work required of draftsmen. In the same book is kept a record of all the work done on any charts, who did it, how long it took, what was done, and how much it cost. This latter account of work done is supplemented by two other books called Record of Work Books.

The arrangement of these books is shown by the following headings:

Information Book.

Date of entry.	Information or data which may affect our charts.	Date of information.	Charts affected.	Remarks.

Record of the Correction of the Charts of the United States Hydrographic Office.

[Chart No. —. Title ——. Limits ——. Scale ——.]

Plate No.	Sources from which the chart requires correction.	Record of work.			Cost of work.		Nature of corrections made or work done.
		Page of draftsman's record.	Page of engraver's record.	Date finished.	Drafting.	Engraving.	

Record of work in the Division of Chart Construction of the United States Hydrographic Office.

DRAFTSMEN.

Date of entry.	Chart No.	Locality.	Record of correction.		Record of construction.		Draftsman.	Began.	Finished.	Number of hours.	Revised.	Entered on engraver's record.
			Vol.	Page.	Vol.	Page.						

Record of work in the Division of Chart Construction of the United States Hydrographic Office.

ENGRAVERS.

Date of entry.	Chart No.	Locality.	Record of correction.		Record of construction.		Engraver.	Begun.	Finished.	Number of hours.	Revised.	By whom revised.	Remarks.
			Vol.	Page.	Vol.	Page.							

In order that the history of charts hereafter made may be complete from their beginning, a book similar to the Record of Correction of Plates, called Record of Construction of Charts, is kept. In it all the data used or consulted in the compilation of new charts and all work done on them is recorded. The arrangement of this book is as follows:

Record of the Construction of the Charts of the United States Hydrographic Office.

[Chart No. —. Title ——. Limits ——. Scale ——.]

Plate No.	Sources from which chart is constructed.	Record of work.			Cost of work.		Nature of information and or work done.
		Page of draftsman's record.	Page of engraver's record.	Date when finished.	Drafting.	Engraving.	

Special attention has been paid to the improvement of the appearance, uniformity, and utility of the new charts published. A standard method of treating every portion of the process of constructing a chart has been, as far as possible, devised and adopted. As to shore lines, topography &c., the object kept constantly in view has been that of usefulness to the navigator. The rule adopted for sanding is to carry it out to three fathoms, and where necessary to define channels of less than three fathoms, to sand out in a darker shade to one fathom. A very careful investigation has been made during the year into the different systems of delineating hill work in use by other hydrographic offices, and it has been decided to adopt, as the most suitable for the needs of this office on large scale charts, that of contour lines in conjunction with roulette shading. The new chart of No. 938, Chamela Bay, West Coast of Mexico, which is appended, is the first published in that style. It is not considered a good specimen of the style, having been published under the difficulties incident to first trials.

The following rules in regard to lettering have been adopted:

(1) Reduce the amount of lettering as much as possible in order to keep chart clear.

(2) Where possible, size and style of lettering are to conform to that in use by Coast and Geodetic Survey Office.

(3) All lettering referring to land to be vertical, and all lettering referring to water to be leaning, except soundings which are vertical.

(4) All lettering referring to aids to navigation to be in block letters.

(5) All lettering to be placed horizontally, as far as possible.

(6) All lettering to be placed on the land instead of the water where there is a choice.

Much of the information which formerly encumbered the body of the chart has been taken off, and given in tables, near the title.

As far as possible these tables have been made uniform with those on Coast and Geodetic Survey charts. The system of abbreviations of bottoms used on Coast Survey charts has also been adopted.

A standard for determining the style of border to be used on any chart and for the lettering appertaining to the border has been adopted. The appended lithograph of the standard borders will show how this is accomplished.

A new compass has been adopted both for harbor and sailing charts, the principal improvement being the division of the true compass into degrees. Illustrations of these compasses are appended.

A set of standard scales for harbor charts has been devised and the rule adopted to put the scale just inside the lower margin and in the middle of the chart. An investigation of the best scales on which to publish harbor charts has been made, and those of 1 inch, 2 inches, 3 inches, 4 inches, and 8 inches to the nautical mile have been adopted. The scale of 3 inches is to be used only when absolutely necessary. These were adopted because a navigator, knowing the scale to be 1, 2, 4, or 8 inches, can very easily estimate distances on the chart by the eye, and all harbors being on the same scale, *or multiples of the same scale*, he can compare the size of one harbor with that of another without difficulty.

The standard sheet of scales is appended.

ON THE SELECTION OF CHARTS TO BE PUBLISHED.

The object of the Hydrographic Office is to furnish cheap and accurate nautical charts. Heretofore this has been attempted almost exclusively by reproducing British Admiralty charts. But the original British charts are as intelligible and convenient for American seaman as our republications, especially if they are reproduced by lithographing or heliograving. It would be much cheaper and more satisfactory to buy the charts directly from the Admiralty office. If the object of thus reproducing Admiralty charts has been to become independent, it has failed. Comparatively few of the Admiralty charts have been canceled. The small number will become evident if those canceled by U. S. Coast Survey charts are left out of consideration. And if a fair comparison of all our duplicates with the Admiralty originals is made, and the poorest withdrawn from issue, this will become more apparent.

What charts should be published? First, those which are publications of our own surveys; second, foreign charts which are not republished by the Admiralty office, and which would be of use to American seamen. These charts should be republished because they are in foreign languages and scales, and therefore require translation. Third, such charts should be compiled as shall be cheaper, more accurate, more intelligible or of better limits and scales for our use than the existing Admiralty charts of the same localities. Fourth, when our list of charts

has become so large that it seems practicable to have a compl of the world, or of any part of the world, to republish all charts, A alty or other, which may be necessary to complete the list and make us independent.

In a tabulated form these classes of charts are as follows:

(1) Publication of original surveys by United States vessels.

(2) Publication of foreign charts (not British) of foreign surveys.

(3) Publication of such coast or sailing charts (compiled from all sources) as can be made better for our use than the existing Admiralty charts.

(4) Publication of all charts necessary to complete a set of charts for the world, or for any special part of the world.

The past year has been spent in working on the first and third classes, considering the means too small to do anything with the second. A nearly complete set of charts has now been made or begun for the West Indies and for the vicinity of Newfoundland, so that it would seem desirable to publish all charts necessary to complete these sets, and the following list, recommended to be taken in hand, is selected with that object in view. There will only be the charts of the survey of the west coast of Mexico by the Ranger the past season, and perhaps a few important foreign charts which should take precedence of these.

Charts required to complete the set of harbor charts of the West Indies and the North Coast of South America.

	Name.	Number of copies of old photolithograph edition on hand.	Remarks.
	WEST INDIES.		
*	Puerto Frances, Cuba	None.	Was on old H. O. 516.
*	Port Santiago de Cuba, Cuba	88	
	Port au Prince and vicinity, Haiti	142	
*	Port au Prince Harbor, Haiti	....	Only a poor plan now on H. O. 3; a general chart of another part of West Indies.
	Cape Hayti Harbor, Haiti	....	
	Monte Cristi to Fort Dauphin Bay and Fort Dauphin Bay, Haiti.	138	
*	Manzanillo Bay, Haiti	82	
*	Caldera Bay, Haiti	16	
	Port San Juan, Porto Rico	137	
	Gorda Sound, Windward Islands	181	
	Christianstead Harbor, Windward Islands	110	Also a special chart of Santa Cruz Island.
*	Orangetown Anchorage, Windward Islands	67	Also a special chart of Saba Island.
	Falmouth and English Harbors, Windward Islands.	154	
	Plymouth Anchorage, Windward Islands	150	Also a special chart of Montserrat Island.
	Basse Terre Road, Windward Islands	133	
	Grande Bourg Marie Gal., Windward Islands.	172	
*	Saint Anne Anchorage and Port du Moule, Windward Islands.	92	Would be better as separate charts.
*	Salée River, Port Saint Marie, and Port Louis, Petit Havre.	....	
*	Saint François and Goat Anchorages, Windward Islands.	98	Would be better as separate charts.
	Saint Pierre Road, Fort Royal Bay, La Trinité Bay, and Cul-de-Sac Marin, Windward Islands.	36	Would be better as separate charts.
	Four ports on Sta. Lucia Island	131	Would be better as separate charts.
	Kingston, Great Head and Caliagua Bays, Windward Islands.	131	
	Admiralty Bay, Windward Islands	171	
	Carlisle Bay, Windward Islands	82	May be put on chart of Barbadoes.
	Tobago Bay Anchorage, Windward Islands.	161	May be put on chart of Grenadines.

Charts required to complete the set of harbor charts of the West Indies, &c.—Continued.

	Name.	Number of copies of old photolithograph edition on hand.	Remarks.
	WEST INDIES—Continued.		
	Saint George Harbor and Port Egmont, Windward Islands.	134	
	Courland Bay, and Rocky Bay, and Tobago Island, Windward Islands.	154	May be put on chart of Tobago.
	Kingston, Port Royal, and Morant Cays, Jamaica.	137	
	Morant Bay, Jamaica	179	
	Port Morant, Jamaica	174	
	Port Antonio, Anatto Bay, Saint Ann Bay, Falmouth Harbor, Savannah la Mar, and Black River, Jamaica.	173	
*	Turk's Island, Hawk's Nest Anchorage, Cockburn Harbor, Mirapor vos. Crooked Island, and Crooked Island Anchorage.	35	Would be better as separate charts.
	Matthew Town Road and Alfred Sound	156	
*	Acklin's Island Anchorage	None.	
*	Pelican and Little Harbors	None.	
*	Green Turtle Cay	None.	
*	Man-of-War Cay	None.	
	Wide-Opening Ship Channel, Egg Island to Eleuthra, Royal Island Harbor, Fleeming Channel, and Great Stirrup Cay.	144	
	Ragged Island Harbor, Clarence Harbor, Wax Cay Cut, Douglas Road, and Highbourne Cut.	135	
	Salt Cay Anchorage and Hanover Sound	143	
	Great Exuma Harbor and Nurse Channel	149	
	Racoon Cut and Ragged Island Anchorage	151	
	NORTH COAST OF SOUTH AMERICA.		
*	Puerto Bello	51	
	P. Escoces and Caledonia	138	
*	P. Carreto, Candelaria Bay, and Port Cispata.	None.	Would be better as separate charts.
*	Harbor of Cartagena	146	The lithograph is incorrect.
*	Rio Magdalena, San Juan Bay, and Bahia Honda.	None.	Would be better as separate charts.
*	Sta. Anna Harbor, Chichirivichi Bay, P. Tucacas, P. Cabello, P. Turiamo, La Guayra, Corsarios Bay, and Port El Roque.	24	Would be better as separate charts.
	Orchilla Harbor	343	
	P. Barcelona, P. Mochima, P. Obispo, P. San Juan Griego, P. Pampatar, P. Moreno, P. Santo Bay, Carupano Bay, Esmeralda Bay, Unare Bay and Cumana Anchorage.	112	The photolithograph plan of Cumana is incorrect.

The charts in the preceding list which are marked * are needed immediately, because the Office has none or the photolithographs are nearly exhausted. The estimated cost of publishing them is about $8,000. Many are of small and unimportant ports, but are required to complete the set.

Those not marked * are charts of which enough copies of the old photolithographed editions are on hand to last some years, and are not immediately required. It would be a better policy, however, to commence replacing them at once by good engraved charts. The estimated cost of those not marked * is about $15,000.

This list can be reduced, if required, by referring it to the proper authority for the rejection of such harbors and anchorages as have ceased to be of any commercial or naval value.

Charts required to complete our set of coast charts in the West Indies.

	Name.	Number of old photo-lithographed edition on hand.	Remarks.
*	Island of Puerto Rico	None.	Scale, ½ inch.
*	Anegada Passage	None.	Scale, ½ inch.
	Island of Barbuda	144	Scale, 1 inch.
*	Island of Antigua	None.	Scale, 1 inch.
*	Islands of Saint Eustatius, Saint Christopher, and Nevis	67	Scale, 1 inch.
	Island of Montserratt	150	Scale, 1 or 2 inches.
	Island of Dominica	128	Scale, ½ or 1 inch.
	Island of Martinico	117	Scale, 1 inch.
	Island of Saint Lucia	131	Scale, 1 inch.
	Island of Saint Vincent	....	Scale, 1 inch.
	Island of Grenadines	....	Scale, 1 inch.
	Island of Grenada	....	Scale, 1 inch.
*	Island of Barbadoes	33	
	Island of Tobago	163	
*	Island of Trinidad	None.	Scale, ½ inch. 2 sheets.
	Island of Margarita and vicinity	112	
*	Island of Oruba	None.	
*	Islands of Curaçao and Buen Ayre	None.	
	Bahama Banks (4 sheets)	130	To replace H. O. 26a, 26b, 26c, one sheet of these has been already.
*	Southwest coast of Jamaica	None.	
*	Pedro Bank, Jamaica	None.	
	South coast, Jamaica	176	
	Southeast coast, Jamaica	137	

In the preceding list the charts marked * are wanted immed because the office has none or because the photolithographs are exhausted. The estimated cost of publishing them is about $10

Those not marked * are charts of which enough copies of t photolithographed charts are on hand to last some years, tho would be better to commence replacing them at once by good en ones. The estimated cost of those not marked * is about $20,0

See accompanying index chart of West Indies and north c South America for a graphic illustration of these required chart charts now on issue are shown by full lines, and those proposed are shown in broken lines.

Charts required to complete our set of general coast charts around Newfound

	Name.	Number of old photo-lithographed edition on hand.	Remarks.
*	Great Banks, Sheet I	....	To replace old H. O. 9, 15, an extend new scheme of co from Halifax to Saint Jo foundland; scale 4½ inch
*	Great Banks, Sheet II		
*	Gulf of Saint Lawrence		
*	West Coast of Newfoundland, Sheet I	None.	Would take place of B. A.
*	West Coast of Newfoundland, Sheet II	None.	Would take place of B. A. 2
*	East Coast of Newfoundland, Sheet I	None.	Would take place of B. A.
	East Coast of Newfoundland, Sheet II	168	
	East Coast of Newfoundland, Sheet III	167	
	East Coast of Newfoundland, Sheet IV	178	
*	South Coast of Newfoundland, Sheet I	None.	Would take place of B. A.
*	South Coast of Newfoundland, Sheet II	None.	Would take place of B. A.
	South Coast of Newfoundland, Sheet III	....	Would take place of B. A.
*	South Coast of Newfoundland, Sheet IV	None.	Would take place of B. A.

In the preceding list of charts around Newfoundland those m are urgently needed in order to make the charts now in the (use, a broken set of coasting charts being almost useless. They

DIVISION OF CHART CONSTRUCTION,
PLATE AND PRINTING ROOMS,
Hydrographic Office, July 1, 1885.

SIR: I have the honor to submit the following report of the operations of this portion of the Division of Chart Construction for the fiscal year ending June 30, 1885:

The number of copper plates available for printing is 333. From these there were printed 21,025 copies of charts for issue; also 1,087 proofs; total, 22,112.

The comparison with the two preceding fiscal years is as follows:

	Copies.
1882-'83	12,180
1883-'84	16,910
1884-'85	22,112

In addition the force of the Division was employed in miscellaneous printing as follows: Official letter paper, 13 reams; official note paper, stamped, 8¾ reams; official cards for correspondence, stamped, 1,801; official envelopes, stamped, 7,319; forms of clouds, thermometer scales, and deviation diagrams, 1,312.

I would recommend the establishment of an electrotyping plant for reproducing plates. This could be done at less than one-half the present cost, the only important outlay being the cost of the battery and the pay of one good mechanic. The improvement of the quality of work and articles used is being constantly studied.

Respectfully submitted.

THOS. SNOWDEN,
Ensign, U. S. N.

Commander J. R. BARTLETT, U. S. N.,
Hydrographer.

DIVISION OF SUPPLY, HYDROGRAPHIC OFFICE,
July 1, 1885.

SIR: The operations of this Division for the year ending June 30, 1885, have been as follows:

	Third quarter 1884.		Fourth quarter 1884.		First quarter 1885.		Second quarter 1885.		
	H. O. C.	C. S. C.	H. O. C.	C. S. C.	H. O. C.	C. S. C.	H. O. C.	C. S. C.	Total.
Copies of charts received:									
From printing room	4,157	......	4,231	......	5,851	......	7,212	......	21,451
Photolithographed	100	......	761	......	296	......	600	......	1,757
From Coast Survey	......	914	......	2,253	......	359	......	437	3,[illegible]
Total	4,257	914	4,992	2,253	6,147	359	7,812	437	27,171
Copies of charts issued:									
To naval vessels	537	353	2,102	2,068	752	114	1,586	536	8,048
To archives	17	9	33	18	50	13	36	6	182
To agents	2,527	......	1,956	......	2,413	......	2,297	......	9,193
To merchant vessels	531	......	505	......	1,156	......	793	......	2,[illegible]
To merchant vessels, meteorological charts.	174	......	255	......	236	......	253	......	918
To foreign hydrographers	317	......	......	......	87	......	83	......	487
To home correspondents	180	......	96	......	96	......	300	......	672
Miscellaneous	296	109	540	227	569	76	328	95	2,240
Total	4,579	471	5,487	2,313	5,350	203	5,676	637	24,725
Charts published	10	......	18	......	9	......	26	......	63
Copies of charts condemned	437	48	130	40	234	28	330	1	1,248
Charts canceled	18	......	6	......	10	......	9	......	[illegible]
Plans canceled	......	......	......	......	......	......	1	......	1
Copies of canceled charts condemned	1,890	......	1,077	......	1,189	......	850	......	5,[illegible]

It will be seen by the preceding table that the number of charts re-
eived and issued is much greater than that of the previous year, with
the one exception of miscellaneous charts issued. This difference is
lue to fitting out the branch offices with complete sets of charts.

This Division has been engaged in keeping the charts corrected by
ıd, from information received from Notices to Mariners, the hydro-
graphic information accompanying the Naval Intelligence reports from
Jnited States men-of-war, reports of United States naval officers, in-
ormation received through the branch offices, and by comparisons with
oreign charts of late surveys.

Of the charts issued, fully one-half require some hand correction;
e of these are small, but all are important to the navigator. All
ts have a standard which shows the latest information, and before
ing a chart it is compared and made to agree with the standard.

Before printing the plate charts the plate is corrected from the stand-
l, and all corrections made to date of printing, hence the corrections
plate charts are never very great, and in case of extensive changes
edition is printed at once and all old copies called in.

With the photolithographed charts all corrections have to be made by
ıd, and as these corrections have been accumulating since the publi-
ion of these charts, which in most cases was in 1873–'75, they have
ome too numerous to be handled in this manner. The hydrography
cl ged in many cases, especially at the mouths of rivers, new
and rocks have been discovered, and the longitude by recent de-
ions has been found to be erroneous in many places. All these
rrors, with constant alterations of lights and buoys, have made the cost
making these corrections far greater than the chart is worth. Most
the photolithographs are printed on paper that is not well adapted
erasures and corrections. As fast as these charts are compared
with later surveys and found to need extensive corrections that are not
the interest of economy to make, they are canceled and a foreign
art taken up in its place for the use of United States vessels, while
nts are informed that they may return any copies on hand.

The number of photolithographed charts on hand at present is 381;
ost of them have to be corrected before they are sent out, and many
uire quite extensive additions and corrections. Comparisons with
e charts are being made as fast as possible, and no doubt many of
these photolithographs will be condemned during the next year.

In addition to the regular work there has been prepared and pub-
d by this Division a complete set of index charts of the world, show-
ing all charts published by this Office. These index charts are at present
otolithographed, but it is hoped they can soon be engraved, when
rections and additions can be more easily made from time to time.
e cost of engraving them will be very little in comparison to their
ulness.

During the year many reported dangers which have been shown on
charts for years have been removed, most of them from the sailing
rts of the Atlantic Ocean. No reported danger was removed except
er a careful investigation and study of all reports and authorities on
subject and there was absolutely no positive reason why it should
there. Many of the rocks formerly reported were undoubtedly float-
ice, derelicts, buoys, or floating timber.

espectfully submitted.

W. O. SHARRER,
Lieutenant, U. S. N.

Commander J. R. BARTLETT, U. S. N.,
Hydrographer.

DIVISION OF ISSUE, HYDROGRAPHIC OFFICE,
July 1, 1885.

SIR: I have the honor to submit the following report of the operations of this Division for the fiscal year ending June 30, 1885:

In addition to its ordinary duties this Division has had the issuing of all chart publications to naval vessels and others under the Government employ, such as those of the Coast Survey and Fish Commission.

At the time when the catalogue of charts for vessels on the several stations was divided into three parts, according to the offices of publication, the Hydrographic Chart Division furnished the Hydrographic and Coast Survey charts to the service, but upon the completion of the new edition, in which these charts were arranged with reference to their geographical position, it was thought advisable to place the whole system of issue under one head.

The Hydrographic Chart Division then became that of Supply, while the Admiralty took its present name and duties.

When an order is received to fit out a vessel, requisition is made on the Supply Division for Hydrographic and Coast Survey charts, which, when received, are carefully marked and assigned to their respective portfolios.

Two copies of the Catalogue for the Station are forwarded with the portfolios, one for the commanding officer and the other for the navigator; a third copy is kept in the Office, and is at all times a complete index of the charts on board.

All vessels to which charts are issued are now provided with the new edition which has proved of great service to the navigator, insuring accuracy in correcting charts as well as greater facility in their selection from the different portfolios. A supplement has been completed to be issued to flagships only. It is composed of two portfolios containing a sufficient number of charts to enable a vessel to go around the world or from one station to another.

The following table gives the number of charts issued to vessels on the different stations divided according to the offices of publication.

Office of publication.	North Atlantic Station.	South Atlantic Station.	European Station.	Asiatic Station.	Pacific Station.
United States Hydrographic Office	231	150	103	270	310
United States Coast Survey Office	288	40	40	77	166
British Admiralty Office	171	138	835	835	217
French Hydrographic Office	....	1	....	24	10
Indian Survey	....	....	....	4	....
Total	690	329	978	1,210	703

It will be seen from this table that on two stations at least we are dependent upon foreign charts for navigation in those waters.

As the work of resurveying is being extensively carried out by foreign hydrographic offices, not only are new charts being published but great changes are found on the new editions of the old ones, and as our photolithographic charts can only be corrected by hand it will be necessary before many years to replace the latter by British Admiralty charts.

The Indian Survey charts issued refer to ports on the coast of India, while those of the French are surveys of the coasts of New Caledonia, Anam, and a small port on the west coast of Africa; these charts are

not of recent date, but are deemed of sufficient importance to be retained.

The force of the Division has been employed in the examination of charts received from abroad, and correcting them from the latest information, such as Notices to Mariners, Hydrographic Reports from United States Vessels, and complimentary charts sent by the British Hydrographic Office. When the latter charts show important additions the dispatch agent in London is instructed to forward copies to vessels on foreign stations.

Commanding officers are now required to report the latest date of correction on charts so that the office may be certain that the latest editions have been sent from London.

All ships in commission have been supplied with charts of the latest date.

The following smmmary shows the number of copies of charts received, issued, &c., for the year.

RECEIVED.

	Copies.
From J. D. Porter, agent for Admiralty charts, London	6,750
From United States vessels	389
From British Admiralty, complimentary	221
From miscellaneous	29
Total	7,389

ISSUED.

To United States vessels	3,612
To United States vessels through dispatch agent, London	987
To Division of Notices	1,647
Miscellaneous	196
Total	6,442

CONDEMNED.

Being unfit for use	2,003

BALANCE.

On hand	12,076

Respectfully submitted.

J. RUSSELL SELFRIDGE,
Lieutenant, U. S. N.

Commander J. R. BARTLETT, U. S. N.,
Hydrographer.

DIVISION OF BOOKS, HYDROGRAPHIC OFFICE,
July 1, 1885.

SIR: I beg to submit herewith a report of this Division for the year ending June 30, 1885.

Books, pamphlets, and nautical forms.

	Third quarter, 1884.	Fourth quarter, 1884.	First quarter, 1885.	Second quarter, 1885.	Tot ye
Received from—					
Government Printer	2,532	500	300	342	
Navy-yards and vessels	2	134	79	2,560	
Home agents	155	....	170	16	
Foreign agents	....	5	175	101	
Bureau of Navigation and other Government Departments	195	358	160	692	
Total received during the year	2,884	977	884	3,711	
Issued to, and expended—					
United States vessels	188	1,704	158	3,264	
Agents	516	441	195	217	
Main and Branch Hydrographic Offices	229	211	168	342	
Home correspondents	44	4	9	16	
Foreign correspondents	380	2	....	13	
Miscellaneous	41	249	252	145	
Canceled and condemned as unserviceable	....	58	140	251	
Total issued and expended for the year	1,398	2,669	922	4,248	

Books, pamphlets, and nautical forms on hand: For issue to v 37,[illegible]98; for reference, 950.

Preparing for publication: Supplement No. 1 to H. O. No. 73. foundland and Labrador, 1884.

The following changes were made in the issuing list:

Books canceled or withdrawn.	Books placed on.
H. O. Nos. 30, 31, 32, 33, 33*a*, 33*b* (light lists 1 to 6, inclusive), corrected to July 1, 1883.	H. O. Nos. 30, 31, 32, 33, 33*a*, 33*b* (light lists inclusive), corrected to July 1, 1884.
H. O. No. 55, Remarks upon Magellan Straits, Leferre, 1874. H. O. No. 44, supplement Navigation Magellan Straits, 1883. B. A. South American Pilot, Part II, 1875.	B. A. South American Pilot, Part II, s ment, 1885.
B. A. West India Pilot, Part I, 1883.	H. O. No. 64. Caribbean Sea and Gulf of ico, Vol. II, 1885.
B. A. Australian Directory, Vol. I, 1876.	B. A. Australian Directory, Vol. I, 1884.
B. A. West Coast of England, 1876.	B. A. West Coast of England, 1884.
B. A. Black Sea Pilot, 1871.	B. A. Black Sea Pilot, 1884.
B. A. British Channel, 1879.	B. A. Bristol Channel, 1884.
Book of the Stars (Proctor).	B. A. supplements 1 and 2 to China Sea I ory, Vol. I, 1864.
Nautical monographs, Nos. 1, 2, 3, 4.	B. A. Supplement 1 to China Sea Director II, 1884.
Memoir of the North Atlantic (Purdy and Findlay).	B. A. Fiji Islands and adjacent waters, s ment, 1884.
Lights on the Atlantic and Pacific coast of the United States.	B. A. Sailing Directions for Mauritius Is 1884.
	Eldridge United States Coast Pilot 1 and 2

SUMMARY.

	Bool
Received during the year	
Issued, condemned, and expended	
Withdrawn from issue, out of date	
New books published by H. O	
New books or later addition placed on list	
On hand for issue	
On hand for reference	

books are canceled or withdrawn from issue, one copy is re-
ır reference, the rest destroyed and sold as waste paper.
; the latter months of the fiscal year just closed a new arrange-
storage of books for issue was inaugurated with a marked saving
ınd labor in fitting out vessels, filling requisitions, and keeping
l the various volumes of sailing directions necessary to the im-
outfit of five vessels of war.
ɔrary of this Division, containing nearly a thousand works of
ɔ, is being rearranged and catalogued upon a system that, while
g of indefinite expansion, will always insure dispatch and ac-
ı obtaining any information on hand pertaining to the various
relative to the work of the Hydrographic Office.
ɔ be regretted that of the ninety-nine volumes of sailing direc-
ıed to vessels of the United States, fifty-eight are English edi-
f the remainder, published by this Government, many are either
ıte or duplicates of recognized foreign standards.
ation of the Atlantic Ocean, Hydrographic Office Publication
edition of 1873, has run out, and being the best book at present
n that subject, should be reprinted with such modifications as
ion since that date would necessitate.
d respectfully lay before you the following facts and sugges-
have forced themselves upon the management of this Division
ne past year, viz:
ing, as previously cited, more or less dependent upon foreign
for works on sailing directions, it would be to the decided ad-
of the Government to be able to rely wholly upon its own de-
ts for all information necessary to the safe movements of its own
especially in times of war. With this end in view, to this Di-
ould be intrusted the care of the compilation and revision of a
of sailing directions, apportioning the work to the various
s of the Hydrographic Office, keeping constantly in sight the
acilities of obtaining the most accurate and recent information
greatest dispatch. Having compassed our own, the Western
ıere, the work should extend east and west beyond our coast lines
eting, be it in Europe or Asia, we have at command complete
irections of the world. Should such a plan be initiated the force
Division must be at once increased to six officers, the present
being wholly inadequate for such an undertaking.
the preparation of such works great care should be taken to
all matter of an ephemeral nature, such as the position and
buoys and beacons, the colors and intensities of lights, the di-
s of incomplete harbor works and improvements, objects whose
are so rapid that many would occur while the work is in press
n whose accuracy reliance alone can be placed upon charts and
s; these works should contain rather all such information as a
der of a vessel might require, and which from its peculiar nature
t be elsewhere embodied.
ıe suppression and recall of all publications that are either out
or duplicates, thus lessening materially the study and care of
ding officers, especially where the information in works on the
bject is at variance or missing.
in future a continuous numerical annotation be given to all
ıished by the Hydrographic Office, and that the use of subdi-
e. g., 30, 30*a*, 30*b*, &c.) be discontinued.
l agents and firms interested in the sale of nautical works

be requested to send constant information in regard to their newest publications, so that the library of the Office may purchase and contain the latest works on all matters pertaining to hydrography.

Respectfully submitted.

RICHARD G. DAVENPORT,
Lieutenant, U. S. N.

Commander J. R. BARTLETT, U. S. N.,
Hydrographer.

DIVISION OF NOTICES, HYDROGRAPHIC OFFICE,
July 1, 1885.

SIR: During the fiscal year ending June 30, 1885, five hundred and six notices to mariners, containing one thousand and twelve announcements, were issued. Two thousand one hundred and thirty foreign notices to mariners, in ten different languages, were received, and all containing new information translated and republished.

Six volumes of light-lists, embracing all the lights of the world, were corrected to July 1.

The domestic and foreign charts on file in this Division, eight thousand eight hundred and seventy-eight in number, were rearranged, all the old catalogues corrected, and a number of new catalogues made of foreign charts.

The care and arrangement of the archives of the Office having been assigned to an officer, I submit his report as supplementary to my own.

Respectfully submitted.

W. H. PARKER,
Lieutenant U. S. N.

Commander J. R. BARTLETT, U. S. N.,
Hydrographer.

DIVISION OF NOTICES, ARCHIVES,
July 1, 1885.

SIR: The regular routine work of receiving, classifying, and filing away all documents, charts of surveys, data, reports, and other hydrographic information, for certain and convenient reference whenever needed, has been continued without interruption, and at the same time an entire rearrangement of all matter on hand has been pushed rapidly forward, and is now nearly complete. For this purpose a card catalogue has been substituted for the old arrangement, and whilst the former methods have been simplified, the convenience and certainty of reference have been increased.

In order to enhance still further the value of the cards, I would suggest that each should show on its face the source and date of the information, thus limiting to a minimum the documents to be consulted; and as the cards are all arranged alphabetically it would simplify matters to adopt a preferred spelling for all words in use by the Office. This would harmonize at once the many differences now existing in our sailing directions, light lists, charts, indices, and other publications, and increase the certainty of reference in all parts of the office. To more thoroughly harmonize such work the same general rules should govern all indexing.

It would be a saving in many ways to omit such reference words as Bay, Cape, Mount, Rio, River, Saint, Santo, San, St., Port, Porto, using only the proper name in every case.

The geographical sections should be exactly defined and limited by degrees of latitude and longitude; a chart of the world showing such limits is needed for constant use in this room. At present the limits are somewhat indefinite.

It is desirable that separate reports should be made on each special locality, and that one uniform style of paper be used.

Tracings should never be made on paper, as it is not suitable for preservation and after a few years breaks and crumbles away; cloth should be used.

Respectfully submitted.

G. A. MERRIAM,
Lieutenant, U. S. N.

Commander J. R. BARTLETT, U. S. N.,
Hydrographer.

DIVISION OF METEOROLOGY, HYDROGRAPHIC OFFICE,
July 1, 1885.

SIR: I have the honor to submit the following report: The greater part of the time of this Division has been given to perfecting and compiling the data for the monthly Pilot Chart of the North Atlantic, the continuation of the work on the meteorological charts of the North and South Atlantic Oceans, and the distribution of meteorological journals to the merchant marine of the United States and foreign countries, whose ship-masters have volunteered to make observations for the Office.

The Pilot Chart has been improved from time to time as changes have been suggested, and the appreciation of it by nautical people requires no stronger evidence than the constantly increasing demand that the Office is called on to meet.

The publication of information in regard to the use of oil to diminish the dangerous breaking of seas during gales of wind commenced on the Pilot Chart of January last, appears to have excited great interest among nautical men, and there can be but little doubt that it will eventually demonstrate to them a simple and ready means of materially decreasing the danger in the most violent storm.

One of the most interesting subjects for consideration which a study of the year's Pilot Charts suggests is the general circulation of the currents of the Atlantic as shown by drifting wrecks and buoys. While the movements of some of them have been very erratic, on a whole they confirm the truth of the theory of currents as delineated on the Pilot Chart. In many instances their movements have been evidently so much affected by winds that no correct estimate of the strength of the current can be made, except in the case of the derelict schooner Twenty-one Friends. This vessel was abandoned, water-logged off the coast of Virginia on March 24, in about latitude 36° 30′ north and longitude 72° west. Being lumber laden she continued to float, and as her masts were carried away near the deck there was but little surface exposed to the influence of the wind. From March 24 to April 4 she drifted east-northeast 37 miles per day. From April 4 to April 14 the drift was in the same direction and 39 miles per day. From April 14 to April 28, east by north about 23 miles per day. From this point her reported

positions have been so irregular, and in some cases so conflicting, that her movements have been evidently affected by gales of wind, but from March 24 to April 28, an interval of thirty-five days, she drifted directly along the axis of the Gulf Stream, as indicated, a distance of nearly 1,200 miles, an average of 34 miles per day.

The schooner Maggie M. Rivers, abandoned near Cape Hatteras January 7, 1884, appears to have been driven directly across the Gulf Stream, and on February 6 was sighted in latitude 34° north and longitude 69° 30′ west, having passed out of the influence of the stream. She remained near this position until August, and being directly in the track of vessels coming onto the coast from the equator, was reported many times. After this she appears to have come under the influence of the Gulf Stream, and drifted rapidly to the northeast until the middle of September, when she was again driven south, and on November 13 was towed into Bermuda by H. B. M. S. Canada.

This case presents itself as one that should have demanded the attention of this Government. For nine months this vessel was drifting in the track of commerce, within two days' easy steaming of our coast, and it would seem a very appropriate duty for our men-of-war to search for and destroy such dangers when reported.

Almost the same thing occurred immediately after in the case of the derelict brig O. B. Stillman, which drifted in the same locality from October 9 to February 17, and was finally towed into Bermuda. During the past year there has been received but one report of a vessel having collided with a derelict; how many have not reached their destination from this cause? Certainly we cannot be altogether wrong in believing that some of the many reported as missing may have come to grief in this way.

During the season of tropical hurricanes there were two cyclonic disturbances that originated within the tropics, and one which appears to have developed off the coast of Florida, between Jacksonville and Savannah.

The logs of a large number of merchant vessels were consulted by the officers of the branch hydrographic offices, and the data extracted, in connection with the Signal Service reports, were sufficient to plot their tracks, as given on the Pilot Charts of November and December.

The first one appears to have developed in latitude 18° north, longitude 47° west, on September 3. It moved slowly to the northward and westward until it reached latitude 32° in longitude 57° west, where it curved to the northeast and passed over the Central Atlantic toward the European coast, the only remarkable feature about it being the very slow motion of its axis. From September 4 to 14 it only advanced at the rate of about 6 miles per hour.

On September 12 a disturbance appears to have moved off the coast of South Carolina, which rapidly developed a gale of hurricane force. It moved to the southeast on the 13th, to the south on the 14th and 15th, when it curved to the westward, and one of the reports shows that the center passed directly over a vessel on the 16th in latitude 27° north, longitude 75° 30′ west. It then recurved to the west and north, then north and east, crossing its track of the 13th and 14th of September between the 17th and 18th. At the time of the publication of the Monthly Pilot Chart the reports were not sufficient to trace its path beyond this point, but those subsequently received show that it moved to the northeast across the Atlantic nearly to the British Islands. The abnormal path of the storm must have been very confusing to mariners

its influence and endeavoring to avoid the center. This a num-iled to do, with disastrous results.

third and last one appears to have developed between October d 8th, near the western end of the island of Santo Domingo, from e it moved to the north and west over the eastern end of Cuba. the 9th to the 13th, it appears to have been passing over the na Islands, and, curving to the north and east, no reports were ed of it after the 17th.

report of the steamship Cienfuegos presents the unusual facts of aving twice encountered the same hurricane. In the first in-e, on the night of October 9th, while at anchor in the harbor of San-de Cuba, which port she left on October 13th, bound for Nassau. ctober 14th, at midnight, she again experienced a hurricane from est northwest, the center being nearly north of her. On the 16th rived off Nassau, but was unable to communicate with the harbor count of the sea breaking on the bar.

work on the South Atlantic meteorological charts is well ad-d, but, owing to the reduced number of officers on duty in this on, has been suspended. There are now on hand a large number teorological journals kept by merchant captains containing more s data for these charts, which I would advise compiling.

he squares along the great highways of commerce, between the or and Cape Horn and the Cape of Good Hope, the data is very lant, but along the African coast it is very meager. This is a part ocean seldom visited by vessels of our navy or merchant marine, ie only way that it can be obtained is from the British Government. ig had men-of-war on that coast for many years, and controlling the f large numbers of merchant steamers passing along that coast the opening of the Suez Canal, the English Government probably e desired information.

ing this fiscal year one thousand and sixty meteorological jour-ave been issued to the merchant marine, and three hundred filled ils have been turned in.

pectfully submitted.

SETH M. ACKLEY,
Lieutenant, U. S. N.

nmander JOHN R. BARTLETT, U. S. N.,
Hydrographer.

UNITED STATES BRANCH HYDROGRAPHIC OFFICE,
Custom-house, Boston, Mass., July 1, 1885.

: In accordance with instructions I herewith forward a report of rk of the Boston branch of the Hydrographic Office, United States for the fiscal year ending June 30, 1885.

number of vessels visited was 2,464, to the masters of which were ned the objects of the office, invitations extended to avail them-of its uses, and all important information relating to their par-r voyages obtained and given.

r thousand three hundred and fifty merchants, mariners, and were furnished with information on various topics, many of the ns being of a non-nautical nature, but in no case were the ques-lisappointed.

office has received during this time 138 important communications

from masters of vessels and others, the knowledge of which made public has been and is of value to seafaring people. In the matter of barometers, 2,028 have been corrected to correspond with the readings of the mercurial standard in this office.

Nearly 500 sailing charts were brought to this office for correction, of which number 364 were corrected free of charge; the remainder, on account of age, were found so inaccurate as to make the labor of correction almost equal to the construction of new charts, and the condi such as to make the charts practically useless.

The masters of 43 vessels were furnished with 120 meteorol journals, to whom were given, free of cost, 600 general sailing c Of the monthly Pilot Charts, 3,000 were distributed during the y Ninety-three reports of the positions of icebergs and floes on and in vicinity of the Grand Banks and of 427 derelicts and wreckages received.

Previous to February 14, 1885, no record was kept of the following items, but since that date 2,532 copies of "Notices to Mariners," 243 c of the Light-House Board's "List of Lights," and 1,502 "Day Marks" have been distributed. There have been received 372 trade-wind limit reports, the data more or less valuable of 43 storms, the positions and conditions of 106 separate fogs, and of 33 water-spouts. A great number of the publications from the various Departments of the Government have been furnished on application, no record of which has been kept.

This statement of work speaks for itself, but to show that the office and its practical work is thoroughly appreciated, I beg to submit a few extracts from letters received from Boston merchants.

Mr. Hunt, of the firm of Charles Hunt & Co., says:

> We have never had occasion to regret our action, taken some time since, in petitioning for the continuance of your important office in this port, and we desire to repeat our high estimate of its value, and the importance attached to its work by those masters of vessels (to our consignment) who have availed of its privileges and been recipients of its favor.

Mr. Lombard, of A. C. Lombard Sons, says:

> Your office has been of great benefit to us since its establishment here, and particularly to the masters of steamships and vessels of all nations to our care, in correcting charts, adjusting barometers, rating chronometers, &c. A number of our captains have told us it was far ahead of anything of the kind on the other side of the Atlantic. We believe the branch offices are daily growing in importance, and that every facility should be given by the Government to extend their field and increase their efficiency.

And Mr. Burt, of Burt, Alexander & Co., says:

> The more fully the objects and scope of the office are known the value of the service increases. We rarely have a master arrive in port now that is not anxious to visit your office and obtain the information which you are so ready to furnish. The charts giving the "ice limits" and location of wrecks are considered very valuable by all mariners, and an increased interest has already been awakened to report any occurrences during their voyages which may be for the interest of the mercantile marine.

The office is almost daily in receipt of verbal testimonials comm ing the action of the Department in establishing these branches in principal sea-ports, as it was a want long felt by merchants.

The efficiency of this branch will certainly increase if some means can be devised for the establishment of a comparatively rapid communication with the maritime interests of the sea-port towns of Gloucester, Portsmouth, Portland, Bath, Bangor, and Eastport to the northward, and Provincetown, Vineyard Sound, and Buzzard Bay ports to the southward.

The following recapitulation shows the work performed at this office from July 1, 1884, to June 30, 1885, inclusive:

Vessels visited	2,464
Information given to individuals	4,350
General information received	138
Barometers adjusted or compared	2,028
Sailing Charts corrected	364
Pilot Charts distributed	3,000
Ice reports	93
Wreck and wreckage reports	427
Buoys adrift	13
Meteorological journals afloat	120
Notices to Mariners distributed	2,532
Light Lists distributed	243
Buoy books distributed	1,502
Trade winds reported	372
Storms reported	43
Fogs reported	106
Water-spouts reported	33
Chronometers rated from October 30, 1884, to April 11, 1885, when rating was suspended	61

Respectfully submitted.

W. A. MARSHALL,
Lieutenant, U. S. N.

Commander J. R. BARLETT, U. S. N.,
Hydrographer.

UNITED STATES BRANCH HYDROGRAPHIC OFFICE,
MARITIME EXCHANGE,
New York, N. Y., July 1, 1885.

SIR: In accordance with instructions I forward herewith the report for the year ending June 30, 1885:

It has been the aim of this office to make masters of vessels comprehend that it is for their special benefit, being a mere medium and a very convenient one, by which each captain gives to all concerned the benefit of his personal experience by reporting any unusual occurrence immediately upon arrival in port. This information is put in proper shape and kept for reference, with copies for distribution, as well as all information in the possession of the Hydrographic Office.

The masters of all vessels arriving at the port of New York are informed of the existence of this office by an officer going on board, by letter or by card. In each case they are requested to call at the office, and are given some idea as to its object and benefits.

Upon the receipt of any report from the master of a vessel an acknowledgment is made and a Pilot Chart sent to him. Pilot Charts are given monthly to all the principal newspapers, exchanges, clubs, shipping firms, and agents, many of whom frame the charts and hang them in conspicuous places, where they can be examined by any one interested.

The following table gives a summary of the work performed:

	1884. July.	August.	September.	October.	November.	December.	1885. January.	February.	March.	April.	May.	June.	Total.
Vessels visited	173	281	230	288	320	224	312	328	417	303	[illegible]	[illegible]	3,7[illegible]
Vessels taking meteorological journals	5	6	7	6	5	4	10	30	30	15	10	[illegible]	1[illegible]
Vessels returning filled meteorological journals	3	1	1	2	4		1	4	3	6	2	6	[illegible]
Meteorological journals issued	11	16	17	15	14	13	23	81	67	37	20	31	[illegible]
Meteorological journals returned filled	8	3	2	2	7		1	9	3	10	6	12	[illegible]
Storm journals issued	9	30	31	8	2	13	2	7	..	......	...	....	1[illegible]
Storm journals returned filled			2	8	5		.	1	...	1	....	....	13
Barometers compared	25	36	23	17	21	12	15	31	61	124	155	215	7[illegible]
Thermometers compared								...	20	25	30	52	1[illegible]
Meteorological charts furnished vessels							12	48	36	72	24	72	[illegible]
Ocean charts furnished vessels	22	46	30	60	65	35	48	123	173	112	39	200	[illegible]
Vessels' charts corrected							1		.	1	..	4	7
Pilot charts distributed	307	418	258	311	382	396	390	404	535	417	538	497	4,[illegible]
Polar charts distributed								....	..	....	....	....	5
Lists of United States lights distributed	2	4	17	9	10	19	19	18	48	68	67	52	[illegible]
Lists of beacons and buoys distributed	5	9	11	27	69	142	135	140	211	209	238	159	1,[illegible]
Notices to mariners distributed	10	11	4	73	75	65	306	1,260	1,882	1,534	3,390	2,961	11,1[illegible]
Information given to captains of vessels and others								117	193	301	424	564	1,[illegible]
Pamphlets distributed.													
Revolving Storms and how to avoid them								..	....	..	....	....	[illegible]
Magnetism of Iron Ships								..	....	..	....	....	[illegible]
Rules of the Road								..	....	....	....	....	1[illegible]
Anti-corrosive and Anti-fouling Paints								..	....	....	....	....	[illegible]
Sound Signals								..	....	....	....	....	[illegible]
Annual Report of Hydrographer								..	....	....	....	....	[illegible]
Instruction to Mariners in case of Shipwreck									...	....	....	....	[illegible]
Coasters' Nautical Almanac, 1884								.	...	....	....	....	[illegible]
Reports received and forwarded to Washington.													
Storms at sea		8	3	17	21	12	7	1	1	..	....	1	[illegible]
Use of oil in gales					..		..	..	3	2	1	....	[illegible]
Wrecks	25	63	63	72	37	24	20	16	24	11	10	14	[illegible]
Buoys adrift	4	6	1	2	6	5	5	3	9	6	1	[illegible]	[illegible]
Water-spouts								..	5	2	3	5	[illegible]
Fog		1							3	1	12	16	[illegible]
Earthquakes at sea					1		1	1	...	....	....	....	[illegible]
Ice	8	24	6	11		1	1	31	84	31	91	82	[illegible]
Trade-wind limits	15	24	35	76	102	84	111	91	169	208	115	106	1,[illegible]

Respectfully submitted.

V. L. COTTMAN,
Lieutenant, U. S. N.

Commander J. R. BARTLETT, U. S. N.,
Hydrographer.

UNITED STATES BRANCH HYDROGRAPHIC OFFICE,
MARITIME EXCHANGE, 131 SOUTH SECOND STREET,
Philadelphia, Pa., July 1, 18 .

SIR: The following is a summary of the work done at this office f
July 1, 1884, to July 1, 1885:

Reports, &c., forwarded:

Storm reports ....
Limits of trades..
Ice ....
Fogs ....
Water-spouts ....
Earthquakes...

...orts, &c., forwarded—Continued.

Electrical storms	2
Saint Elmo's fire	1
Wrecks	256
Buoys adrift	29
General information	7
Use of oil in gales	15
Intelligence reports	22
...rticles distributed:	
Polar charts	25
Meteorological charts	36
Pilot charts	3,728
Soudan charts	10
General sailing charts	82
Notices to mariners	1,229
Light lists	262
Buoy books	811
Nautical almanacs	14
Monograph No. 4	25
Sound signals	92
Magnetism, iron ships	44
Tests of paints	10
Report of Secretary of Navy	14
Mercantile lists	1
Meteorological journals	43
Storm journals	59
Work done by the office:	
Vessels visited	1,538
Information to persons	3,360
Barometers corrected	682
Charts corrected	892
Sextants corrected	1
Thermometers corrected	13

The preceding list gives no adequate idea of the work of the office. In cases where several hours have been spent in overhauling and show- ... the latest charts, they are simply reported as single informations. ...n this manner captains have secured hundreds of corrections to their ...harts without actually bringing them to the office. In many instances, ...regating some hundreds, captains have selected the new charts de- ...d for their proposed voyages by actual inspection of our charts, and ...e then gone to the dealers with the lists in their hands, thus saving ...h much time and annoyance.

...nformation upon a great variety of subjects has been given, until this ...ce has become a bureau of information to residents of Philadelphia ... vicinity, as well as to the shippers and owners and officers of ves- ...s. Single reports to the Office of Naval Intelligence upon ship-yards, ...ry-docks, &c., occupied fully the time of one person for over a week. ... good deal of time was spent in compiling voyages from the Atlantic ...orts of the United States to the East Indies. The time of the officer ...i charge of this office was partly occupied during several months in ...ie experiments in electricity carried on by the Franklin Institute. ...se were of great interest to the naval service and owners of ocean ...amers. A constant effort was made to board every vessel of any size ...iving at Philadelphia. Their meteorological instruments were cor- ...ted, and any information of interest to maritime people obtained. ... work of this office seems to be steadily increasing.

...he publications of the Hydrographic Office are very highly appre- ...ed. The North Atlantic Pilot Chart is received with increasing ...or, and constant flattering comments are heard upon its appearance ... great usefulness. No captain will leave port without it, and its ...ng routes are generally followed, especially during the prevalence ...ice in low latitudes. The demand for it from foreign vessel owners,

insurance companies, maritime associations, and institutions of learning is a gratifying evidence of its appreciation in Europe. No unfavorable comments have ever been heard.

The oil reports are very favorably received, and the knowledge conveyed has unquestionably been of great advantage to vessels in severe storms. There is a general desire for a pamphlet embodying these reports, and the conclusions drawn from them. Many vessels now take casks of oil to sea with them for the special purpose of use in storms. No seafaring person questions its utility.

If possible, fog limits, or the local amount of fog in each month in every square, should appear. More sailing routes are necessary, especially one for sailing vessels during the winter from Europe to the United States.

A request should be printed on the Pilot Chart for full and particular descriptions of all buoys sighted adrift.

The time-ball in the Maritime Exchange was dropped each week-day during the year. This, with the excellent chronometer always accessible to the public, has furnished correct time to hundreds of the business people in this part of the city. In April a time-ball was placed upon the roof of the building, which can be seen by most of the shipping in the river. This time ball is exceedingly useful to captains in giving the exact error of their chronometers.

The branch offices should be furnished with a similar library supplied to our men-of-war, together with a complete set of sailing directions of the world.

Respectfully submitted.

A. B. WYCKOFF,
Lieutenant, U. S. N.

Commander J. R. BARTLETT, U. S. N.,
Hydrographer.

UNITED STATES BRANCH HYDROGRAPHIC OFFICE,
Baltimore, Md., July 1, 1885.

SIR: I beg leave to submit the following report of the work of this office for the year ending June 30, 1885.

In compliance with the orders of the Navy Department dated March 8, 1885, a copy of which is appended, I relieved Lieut. J. M. Hawley, U. S. N., in charge of this office, on March 18, 1885.

I found the office on a firm footing, with Ensign W. S. Benson, U. S. N., as assistant (he having reported for duty on March 13, 1885); J. A. Foxcroft, clerk and boarding officer, and Christian H. Schaub as messenger and office boy.

The work of the office is kept up to date; all charts are corrected according to the Notices to Mariners received. All vessels arriving from foreign ports are visited, as well as all coasting steamers and many coasting schooners, and all the information that can be procured is obtained of them, and their barometers compared with a standard and corrected or the error given.

Shortly before I took charge a time-ball had been established on top of the Baltimore and Ohio Railroad building, corner of Baltimore and Calvert streets, and since I have been here has, with a few exceptions, worked satisfactorily, and is dropped daily (Sunday excepted) at noon of the seventy-fifth meridian.

monthly Pilot Chart is much sought after, and copies are re- by merchants to send to their correspondents abroad. Many vessels use them as sailing charts in crossing the Atlantic, and ition of the ice as laid down on the Pilot Charts is of great value owners and masters.

master of an English steamer informed me that he came near the command of his vessel on his last voyage to England for de- from the safe route as laid down on the May chart, and his have given strict orders that their vessels shall follow the as laid down on the Pilot Charts.

dition to the usual work of the office reports on thirty-three for- eamers on the docking and repairing facilities and on the supply ds of coal at Baltimore, have been furnished the Bureau of Intelligence. Information of various kinds has been furnished uals and corporations.

ld like to suggest that the marine insurance companies be re- l to require their marine inspectors to examine the charts on board vessels they inspect, and report if they are corrected to date. glish Board of Trade requires that vessels should be supplied arts corrected to date of sailing. In this country, in the absence law on the subject, the boards of underwriters are the only ones uld compel owners of vessels to have correct charts.

I have been in charge of this office three English steamers ar- in this port have run on shoals, caused by their not having proper

steamer Midlothian ran on Saint Laurent Reef, using an old " chart of the date of 1879.

Kate Fawcett struck on the 15-foot patch off False Cape, Vir- using an old "Imray" chart of 1878 of the Atlantic Ocean, as a g chart, and on which the shoal was not placed.

Viceroy struck on the same patch, using the same chart, but of a lition.

nclusion, I acknowledge the uniform kindness and courtesy which received from the Board of Trade, the Corn and Flour Exchange, officials, shipping agents, steamship companies, and others om I have been thrown in contact.

ollowing tables show the work done by this office for the year June 30, 1885:

GENERAL INFORMATION FORWARDED.

existence of Isle Vert, Atlantic Ocean, reported by Captain

ual current reported off Cape Hatteras.

rts on use of oil at sea in calming the water, 12.

rt on loss of the English bark Erinna.

rt on loss of the English steamer Benwell Tower.

lcation of Saint Laurent Reef, Caribbean Sea, reported by Cap- atson.

omenal fall in temperature of water off the coast.

	Six months ending— December 31, 1884.	Six months ending— June 30, 1885.	Total
Vessels visited	1,005	996	2,001
Pilot Charts distributed	1,214	1,289	2,503
Barometers examined and corrected	315	345	660
Light Lists distributed	....	245	245
Day Marks distributed	....	196	196
Notices to Mariners distributed	....	26	26
Meteorological journals placed aboard	10	22	32
Storm journals placed on board	12	3	15
Abstracts of logs copied	54	45	99
Special storm reports	....	29	29
Wrecks reported by	16	17	33
Ice reported by	5	43	48
Fog reported by	....	22	22
Buoys adrift reported	5	5	10
Limits of trade winds	82	117	199
Water-spouts reported	2	10	12
Information to masters, &c., at office	238	266	504

Respectfully submitted.

S. L. GRAHAM,
Lieutenant, U. S. N.

Commander J. R. BARTLETT, U. S. N.,
Hydrographer.

UNITED STATES BRANCH HYDROGRAPHIC OFFICE,
MARITIME ASSOCIATION,
New Orleans, La., July 1, 1885.

SIR: I have the honor to make the following yearly report:

This office was established during the quarantine season and at the time of my last yearly report, July 1, 1884, little could be said in regard to its future usefulness, except the promise given by the hearty interest taken by the business community in general, and especially by those interested in maritime commerce, such as ship agents, brokers, owners, and insurers. When they learned that the object was to place within easy reach of all citizens and mariners a copy of all charts, books, and other Government publications relating to navigation and commerce as a free library, with officers in charge to distribute and collect all information that could be of present or future use to commerce or science, give timely warning of new dangers, define the laws of nature, and thereby reduce the loss of life and property, they gave it a hearty welcome, and have ever been ready to advance its interest.

Three prominent associations, viz, The Mexican, Central American and South American Exchange, Cotton Exchange, and Maritime Association, desired to have the office located with them and offered the necessary space. The latter was selected as the most appropriate place on account of the similarity of interests, and the officers and members have done all in their power to make the duty successful and pleasant. Located in the center of the maritime business offices it is convenient to all and so arranged that charts, books, and instruments can be inspected, compared, or corrected with ease and rapidity.

The time-ball on the Cotton Exchange and operated from this office is of great service to the city and shipping. Information has been requested by individuals and corporations in various kinds of business, and I believe the office will steadily grow in favor as its object becomes better known.

During the summer months there was very little shipping in the port, and, with the exception of the New York steamer, it consisted of small steamers and sailing vessels engaged in trade with the islands and

coasts of the Gulf. Much valuable meteorological data might be collected by these vessels if they were better supplied with instruments and would keep the journals. They are constantly cruising, and the meteorological charts contain little information of that locality in comparison with other parts of the Atlantic, because large vessels and men-of-war have not been much in those waters. The demand for good coast and harbor charts of the Gulf and islands is increasing rapidly on account of the impetus given to trade by the employment of capital in various industries, such as railroads, mines, hard woods, and tropical fruits. The railroad facilities at New Orleans for rapidly distributing tropical fruits and perishable products throughout the West and South have created a growing demand that will continue till all land suitable for that purpose is under cultivation. The number and size of steamers increase with this demand.

In September the transatlantic steamers began coming in numbers, and during the year nearly every vessel was visited, the object of the office explained, information given and received. In many cases the information received in regard to cyclones, gales, trade-wind limits, and such subjects was not as complete as desired for computing the storm center, track, area, or discussing the effect on instruments. The masters had taken frequent observations of wind, weather, sea, and instruments, for their own guidance at the time, but did not record them, as they did not know that offices had been established to collect and make use of such data for future navigators. With very few exceptions the masters and officers at once recognized the value of such offices and promised their hearty co-operation in the future. Their subsequent visits proved their interest, and I believe their reports will be more numerous and complete, but in many cases they were too busy to think of the matter until after the occurrence, too late to give the data most wanted. Therefore, I think some method should be devised to call their attention to it at the proper time and make it as easy for them as possible. I can think of no better means of doing so than by additions to the Pilot Charts and a pamphlet for the captain's table. The officers in charge can call attention to the subject if they see the masters, but many of them are not seen by the officers, and the clerks are not well enough informed in professional matters to explain or discuss them. The Pilot Charts are very popular with the masters, and the agents and insurers are particular to see that they are supplied before sailing, and believe that they will save many vessels from destruction by their valuable warnings, any one of which would pay the expense of all the branch offices for many, many years. These charts are kept ready at hand by the masters, frequently consulted, and many plot their positions on them daily and compare their actual experiences with the mean of the experiences of the past as shown by the charts. Therefore, I believe the best method of calling their attention at the proper time to the subjects about which information is wanted, is to print or stamp it on these charts in the localities where they most frequently occur. I wrote such requests on the charts issued in regard to northers in the Gulf, trades on the limit line, cyclones off the Bahamas, ice off the Banks, rain in the rain belt, and others.

The pamphlet before referred to should state concisely just what information or data is wanted on each subject, without entering into a discussion of it. The master can then know just what is of value to observe during cyclones, northers, and other occurrences without overhauling several volumes on the laws of storms and sailing directions at a time when he has something more important to do, even if supplied with these books.

The commerce of this port is confined to the Atlantic. Foreign steamers generally make a straight run between Europe and the Gulf and pay little attention to meteorological changes, as nothing but very heavy gales, cyclones, and fogs affect them. For this reason there is little demand for meteorological charts and journals as compared with the other ports which send out numerous sailing vessels to all parts of the world. These vessels are generally supplied with foreign charts by the companies, but since this office was opened they have seen the Hydrographic Office charts, and the sale has increased considerably, particularly of the large-scale charts of the Florida coast and channel. This is where most accidents occur, and where they will continue to occur until masters see the necessity of losing a little time in swinging for compass deviations after leaving port with a new cargo in iron ships, and of sounding occasionally through the channel on account of irregular currents.

The following is an itemized statement of work performed:

Vessels visited	600
Information given to individuals	707
Barometers compared or adjusted	485
Charts corrected	2
Pilot Charts distributed	1,569
Notices to Mariners distributed	802
Light Lists distributed	154
Day Marks distributed	247
Polar Charts distributed	30
Valley of the Nile Charts distributed	9
Pamphlets on fog signals	8
Storm reports received and forwarded	8
Trade wind limits forwarded	38
Fog reports forwarded	1
Water-spouts	5
Wrecks	17
Buoys adrift	6
Abstracts from log-books	87
Sperm whale reports	3
Reports to intelligence office	2
Miscellaneous reports	4

Respectfully submitted.

W. P. RAY,
Lieutenant, U. S. N.

Commander J. R. BARTLETT, U. S. N.,
Hydrographer.

[U. S. Branch Hydrographic Office, Merchants' Exchange.]

SAN FRANCISCO, CAL., *July* 21, 1885.

SIR: I respectfully submit the following report of what has been accomplished in this office during the past year, and what should be done during the coming year:

Trade-wind limit reports received from merchant vessels and forwarded to main office	368
Earthquake reports forwarded to main office	1
Wreck reports forwarded to main office	9
General information received and forwarded to main office	12
Vessels visited	1,191
Information given to individuals	1,214
Barometers compared or adjusted	849
Thermometers compared	3
Charts corrected	15
Pilot-charts of North Atlantic distributed	70
Notices to mariners distributed	78
Storm journals distributed	28

ogical journals distributed	321
ıts of the United States distributed	97
·ks of the United States distributed	158
orm journals forwarded to main office	1
eteorological journals forwarded to main office	66
ogical charts distributed to masters of merchant vessels for the keep- meteorological journals	30
aphic Office sailing-charts distributed to masters of merchant vessels ping of meteorological journals	594
aphic Office charts of the Arctic, showing the latest discoveries of A. W. Greely, U. S. A., distributed	39
f the Nile Valley and the Soudan distributed	9
aphic Office publication on magnetism of iron and steel ships dis- ed	7
of meteorological journals unfilled returned to office	5

ng the past year this office has sent to the main office a report on Ship-building on the Pacific Coast" and a report on the Steamship Company's steamers Alameda and Mariposa. Dur- coming year the office should accomplish a great deal more. As coming better known, its benefits are being taken advantage of sters of merchant vessels, shipping-merchants, and insurance ıies particularly, and by the public generally, whenever any takes place of public interest and of a nautical nature. It is possible to estimate in figures what should be accomplished.

ldition to the regular duties, I am engaged in compiling sailing ons for "Islands of the Pacific Ocean": this work should be com- during the coming year.

-signals are received here every day about noon, and at noon, ıe observatory at the navy-yard, Mare Island; and a time-ball ge of this office is dropped each day at noon from Telegraph Hill. ime-ball is used by masters of merchant vessels to compare and eir chronometers. It is also a benefit otherwise, as it is used by ls, jewelers, chronometer and watch repairers, and by the public ly.

nometers are rated in the office by time-signals or by comparing andard chronometer which is kept in the office. This benefit to otains of merchant vessels will be more generally taken advan- as it becomes more generally known. Time-signals and time- ve been in operation since May last.

assistance received from masters of merchant vessels has ex- my expectations, but as the full object of the office cannot be lished without their help, it is necessary to enlist their interest work.

n sufficient data have been collected, so pilot-charts of the North can be published and distributed, as is done for the North At- masters of merchant vessels can then see additional benefit of ce to them, and will take greater interest in making reports of oyages.

office has a good field for getting masters of vessels to keep ological journals, but they are unwilling to buy thermometers, ıently many journals are sent in without complete data on tem- es. If sufficient money could be appropriated for the purchase mometers for masters of vessels who keep meteorological jour- the Hydrographic Office, the efficiency of the office in this par- would be considerably advanced.

ectfully submitted.

J. B. MILTON,
Lieutenant, U. S. Navy.

ınder J. R. BARTLETT, U. S. N.,
Hydrographer.

No. 8.—BUREAU OF STEAM ENGINEERING.

NAVY DEPARTMENT,
BUREAU OF STEAM ENGINEERING,
Washington, October 15, 1885.

SIR: In obedience to your order of September 23, I have the honor to submit to the Department the annual report of this Bureau for the past year, together with the estimates for the fiscal year 1886–'87.

APPROPRIATION, STEAM MACHINERY, 1885.

Amount appropriated for temporary provision for six months ending December 31, 1884, act approved July 7, 1884	$500,000 00
Additional appropriation for fiscal year ending June 30, 1885, act approved January 30, 1885	280,000 00
"And the unexpended balance of the appropriation of $1,000,000, made by the act approved March 3, 1883, for engines and machinery for the double-turreted iron-clads be, and the same is hereby, reappropriated and made available during the last half of the year ending June 30, 1885," act approved January 30, 1885	140,000 00
Total for fiscal year 1884–'85	920,000 00

EXPENDED TO OCTOBER 15, 1885.

For labor in navy-yards and stations, in constructing new engines, boilers, and their dependencies; repairing old boilers, machinery, &c., and fitting vessels for sea service; preservation of tools, handling and preservation of materials and stores	$563,057 60	
For purchase of materials, stores, machine-tools, freights, and incidental expenses	215,290 90	
For payments on foreign stations, for repairs, materials, &c.	73,882 21	
Total	852,230 71	
Less repayments by transfers in the adjustments of appropriations	4,320 25	
Total expenditure		847,910 46
Balance on hand		72,089 54

The larger portion of this balance of $72,089.54, however, is covered by obligations of the Bureau for purchases, &c., at home and abroad, the vouchers for which have not yet been received or the accounts not yet settled.

APPROPRIATION, MACHINERY, DOUBLE-TURRETED MONITORS.

mount appropriated for engines and machinery for the double-turreted iron-clads, act approved March 3, 1883		$1,000,000 00
xpended to October 15, 1885, under contracts dated June 15, 1883:		
For the Puritan	$402,147 23	
For the Terror	156,534 30	
For the Amphitrite	104,356 14	
Total	663,037 67	
he unexpended balance of this appropriation reappropriated and made available during the last half of the year ending June 30, 1885, under the appropriation, steam machinery, 1885, act approved January 30, 1885	140,000 00	
		803,037 67
Balance on hand		196,962 33
he balances yet due under the contracts for the completion of engines, &c., for these iron-clads are—		
On the Puritan	26,327 00	
On the Terror	52,178 02	
On the Amphitrite	104,356 18	
		182,861 20
Balance		14,101 13

This balance of $14,101.13, however, will be required to pay for cost f steam trials and extras to contract of the above-named monitors.

APPROPRIATIONS FOR STEEL CRUISERS.

Appropriation of $1,300,000, act approved March 3, 1883.	
awn out by Bureau of Steam Engineering for the machinery of the steel cruisers	$386,748 00
ppropriated, act approved July 7, 1884, for steel cruisers' machinery	620,000 00
ppropriated, act approved March 3, 1885 (deficiency), for completing iew naval cruisers and dispatch boat (machinery)	86,983 57
Total appropriated (machinery)	1,093,731 57

EXPENDED TO OCTOBER 15, 1885.

On the Atlanta.

yments made on contract	$212,310 00
yments for extras to contract	3,246 23
yment for "civilian expert"	421 00
yments for draftsmen, writer, &c	1,317 00
Total	217,294 23

On the Boston.

yments made on contract	$213,030 00
yments for extras to contract	3,264 23
yment for Herreshoff launch	2,221 67
yment for "civilian expert"	421 00
yments for draftsmen, writer, &c	910 00
Total	219,846 90

On the Chicago.

yments made on contract	$206,420 00
yments for extras to contract	3,318 36
yment for "civilian expert"	589 50
yments for draftsmen, writer, &c	1,148 00
Total	211,475 86

On the Dolphin.

Payments made on contract	$122,760 00	
Payments for extras to contract	7,060 15	
Payments for "civilian expert"	2,430 12	
Payments for draftsmen, writer, &c	208 00	
Total	132 458 27	
Total payments		$781,07
Balance on hand		312,656 31

AMOUNTS TO PAY BALANCES ON EXISTING CONTRACTS.

Balance due on Atlanta	$23,990 00	
Balance due on Boston	23,270 00	
Balance due on Chicago	133,080 00	
Balance due on Dolphin	13,640 00	
Total due (machinery)		193,
Balance		118,676 31

It is expected that this balance ($118,676.31) will be required to pay cost of steam trials, extras, "civilian experts," draughtsmen, writers, watchmen, &c., on the machinery of said steel cruisers.

GENERAL OPERATIONS OF THE BUREAU.

The following table will exhibit the character and cost, in labor materials, of the work done under cognizance of this Bureau for cal year ending June 30, 1885, upon the machinery, boilers, &c., with outfits, stores, &c., of naval vessels, and the expenditures for maintenance, &c., at the several navy-yards and stations:

Name of vessel.	Rate.	Engines, boilers, and machinery.	Stores and outfits.	Total.	Remarks.
Adams	Third	$55,264 45		$55,264 45	New boilers completed, new crank-shaft, and steam capstan furnished.
Ajax	Iron-clad	21 65	$1,243 16	1,264 81	Care and preservation.
Alarm	Torpedo ram	637 88	217 88	855 76	Do.
Alert	Third	46 26	127 57	173 83	In service.
Alert	Fourth	919 59	680 14	1,599 73	Greely Relief Expedition ship.
Alliance	Third	23,047 81	2,932 74	25,980 55	Building new boiler and repairs.
Amphitrite	Iron-clad	69,570 76		69,570 76	Under contract for machinery.
Atlanta	Steel cruiser	4,997 70		4,997 70	Extras to contract.
Bear	Fourth	912 02		912 02	Greely Relief Expedition ship.
Boston	Steel cruiser	4,733 70		4,733 70	Extras to contract.
Brooklyn	Second	13,149 50	884 88	14,034 38	Extensive repairs made.
Camanche	Iron-clad	40 80		40 80	Care and preservation.
Canandaigua	Second	33 66		33 66	Do.
Catalpa	Tug	2,751 55	439 91	3,191 46	Slight repairs.
Chicago	Steel cruiser	1,796 21		1,796 21	Extras to contract.
Cohasset	Tug		3 72	3 72	In service.
Colorado	First	23 86		23 86	Care and preservation.
Constitution	Third	50 26		50 26	Heating apparatus.
Despatch	Fourth	5,973 53	1,731 24	7,704 77	Repairs made. In service.
Dolphin	Steel cruiser	3,373 34		3,373 34	Extras to contract.
Emerald	Tug	321 00		321 00	Slight repairs made. In service.
Enterprise	Third	27 58	839 55	867 13	In service.
Essex	do	6,100 76	1,431 87	7,622 63	General repairs being made.
Fortune	Tug	9,438 06	6 40	9,444 46	Putting in new boilers.
Franklin	First	616 58	1,357 93	1,974 51	Receiving ship Norfolk, Va.
Galena	Third	1,368 11	823 37	2,191 48	Slight repairs made. In service.
Hartford	Second	4,633 94	322 41	4,956 35	Repairs made. In service.
Intrepid	Torpedo ram	1,273 21		1,273 21	Changes being made in engines.
Iroquois	Third	90 11	1,197 65	1,287 76	In service.

essel.	[illegible]	Engines, boilers, and machinery	Stores and outfits.	Total.	Remarks.
	Third	$631 21	$136 95	$768 16	Heating apparatus. In service.
	Iron-clad	595 79		595 79	Care and preservation.
	Third	1,753 13	575 39	2,328 52	Slight repairs. In service.
	do	133 72	1,696 12	1,829 84	In service.
ia	Second	329 45	520 73	850 18	Slight repairs.
	do	819 93	5,380 10	6,200 03	In service.
	Tug	451 79		451 79	Do.
	Third	29,546 98	8,671 68	38,218 66	Repairs and new boilers put in.
	Tug	1,085 37	221 45	1,306 82	General repairs made.
ioh	Iron-clad	15,648 82		15,648 82	New turret machinery made.
	Fourth	36 54	29 18	65 72	In service.
	First	211 01	774 86	985 87	Training ship.
	Third	42,785 30	5,812 45	48,597 75	New engines and boilers completed.
	do	56,570 51	3,263 44	59,833 95	New boilers completed and put in.
ela	Second	5 05		5 05	Store ship, Coquimbo, Chili.
	Iron-clad	595 75		595 75	Care and preservation.
	Tug	1,834 52		1,834 52	Care and preservation. In service.
	Iron-clad	596 61		596 61	Care and preservation.
	do	682 21	1,003 34	1,685 55	General repairs made.
	Tug	[illegible]		924 10	Repairs made. In service.
ebire	Second	314 16		314 16	Training ship.
	First	2,247 98		2,247 98	New boilers completed.
	Tug	4,964 50	593 36	5,557 86	General repairs made. In service.
	Third	446 92	1,247 55	1,694 47	In service.
	Second	23,479 25	7,280 69	30,759 94	Repaired with new boilers.
	Fourth	2 50		2 50	
	Third	41 02	1,155 41	1,196 43	In service.
	Fourth	177 19	465 62	642 81	Do.
	Iron-clad	108 78	1,093 92	1,202 70	Care and preservation.
	Second	33,647 18	15,636 65	49,283 83	Extensive repairs made and new steam capstan furnished.
	Tug	733 47	138 96	872 43	Slight repairs. In service.
	do		245 89	245 89	
	do	2,118 15	1,580 48	3,698 63	In service.
h	Second	3,212 55	191 57	3,404 12	Heating apparatus.
	do	4,402 27	1,757 36	6,159 63	Repairs to engines and boilers. In service.
	Iron-clad	95,914 70		95,914 70	Under contract for machinery.
g	Third	222 71	7,449 69	7,672 40	In service.
	do	9,014 98	3,494 92	12,509 90	Thorough repairs made. In service.
	Tug	294 41		294 41	In service.
	Second	1,373 18	519 10	1,892 28	Thorough repairs commenced.
	Tug	229 42	164 00	393 42	In service.
	Iron-clad	12 00		12 00	Care and preservation.
h	Second	741 47	803 85	1,545 32	In service.
	Tug	2 25		2 25	Do.
	do	1,221 31	779 44	2,000 75	Do.
	Third	50,703 52	3,483 02	54,186 54	New boilers completed. In service.
	Fourth	18,171 94	1,616 18	19,788 12	Thorough repairs made.
	First	38,971 75	6,752 57	45,724 32	General repairs made. In service.
	Iron-clad	104,356 20		104,356 20	Under contract for machinery.
	Fourth	616 94		616 94	Greely Relief ship.
	Second	2,543 32	2,932 23	5,475 55	Repairs made. In service.
	Tug	5 16		5 16	In service.
	Second	81,061 70	243 40	81,305 10	New boilers completed; repairs nearly completed; steam capstan furnished.
	do	6,935 97		6,935 97	Heating apparatus; receiving ship.
	First	109 54	[illegible]	1,072 80	Receiving ship, Boston, Mass.
	Third		1,756 75	1,756 75	
	Iron-clad	21 97	485 07	507 04	Care and preservation.
	Third	33,567 32		33,567 32	Boilers put in.
	do	10,675 53	2,055 19	12,730 72	General repairs made.
l		899,224 88	107,212 24	1,006,437 12	

Expenditures at navy-yards and stations not included in the amount expended on naval vessels.

Navy-yards.	Yard expenses.	Miscellaneous.	Total.
Portsmouth, N. H	$23,737 44	$4,207 71	$27,945 15
Boston, Mass	10,586 83	....	10,536 83
Brooklyn, N. Y	44,424 73	39,833 46	84,258 19
League Island, Pa	6,417 72	2,975 67	9,393 39
Washington, D. C	17,436 18	26,504 32	43,940 50
Norfolk, Va	57,947 90	7,010 26	64,958 16
Pensacola, Fla	4,203 81	160 13	4,363 94
Mare Island, Cal	76,758 67	6,672 91	83,431 58
New London, Conn	916 12	....	916 12
Key West, Fla	2,330 96	2,323 63	4,654 59
Foreign stations	....	1,153 62	1,153 62
Total	244,710 36	90,841 71	335,552 07

PRESENT CONDITION OF MACHINERY OF NAVAL VESSELS, WITH THE WORK REQUIRED ON EACH.

The following will show the present condition and the work required to be done to the machinery of naval vessels to fit them for efficient sea service, or to keep them on such duty during the next fiscal year, according to latest reports, with an approximate estimate of the cost of the same:

Adams (3d rate).—In service. In good condition.

Ajax (iron-clad).—In good state of preservation. Would have to be repaired with new boilers for sea service. ($40,000.)

Alarm (torpedo ram).—In fair condition.

Alert (3d rate).—In service. In fair condition.

Alliance (3d rate).—General overhauling and repairs, with new boilers, commenced at the Norfolk navy-yard. ($38,000.)

Brooklyn (2d rate).—Thorough overhauling and repairs just completed at the New York navy-yard.

Camanche (iron-clad).—Well preserved. Could be made ready for sea service at small cost. ($2,000.)

Canonicus (iron-clad).—Would have to be repaired with new boilers for sea service. ($40,000.)

Catalpa (tug).—In service. Ordinary repairs. ($2,000.)

Catskill (iron-clad).—Well preserved. Could be made ready for sea service at small cost. ($2,000.)

Cohasset (tug).—In service. In good condition.

Despatch (4th rate).—In service. In fair condition. Will require repairs incident to service. ($5,000.)

Enterprise (3d rate).—Returning from full cruise. Will shortly require general overhauling and repairs. ($10,000.)

Essex (3d rate).—Undergoing thorough overhauling and repair at the New York navy-yard. ($20,000.)

Fortune (tug).—Repairs, with new boilers, nearly completed at the Norfolk navy-yard.

Franklin (1st rate).—In service as receiving-ship, Norfolk navy-yard. If fitted for sea would require new boilers (on hand) to be put in, and machinery thoroughly overhauled and repaired. To fit for sea service, $30,000.

Galena (3d rate).—Undergoing general repairs at Portsmouth navy-yard. ($4,800.) Will probably require, during the next fiscal year, new boilers. ($65,000.)

ord (2d rate).—In service. Will soon require thorough over- and repair, with new boilers. ($75,000.)

oid (torpedo ram).—Requires to have completed certain desig- lterations to fit her for a gunboat. ($8,000.)

ois (3d rate).—In service. In fair condition. Will require re- cident to service. ($10,000.)

(iron-clad).—Well preserved. To prepare for sea service,

ta (3d rate).—Returning from full cruise. Will require general ling and repair. ($20,000.)

arge (3d rate).—In service. Will shortly require general over- and repair, with new boilers. ($65,000.)

wanna (2d rate).—If ordered for sea service would require new and thorough overhauling and repair. ($75,000.)

ster (2d rate).—In service. In fair condition. Repairs incident ce. ($10,000.)

h (iron-clad).—In fair state of preservation. To make ready for $3,000.

n (tug).—In service. Repairs incident to continuous service,

m (3d rate).—In service. In good condition.

pac (iron-clad).—In good state of preservation. To fit for serv- 000.

attan (iron-clad).—In fair state of preservation. To fit for serv- 4,000.)

ower (tug).—In service. In good condition.

gan (4th rate).—In service. Repairs incident to service.)

sota (1st rate).—In service as gunnery training-ship. If or- or regular sea service would require extensive repairs and new ($75,000.)

an (3d rate).—In service. In good condition.

acy (3d rate).—In service. In good condition. Repairs inci- service. ($5,000.)

uk (iron-clad).—In good condition. To fit for service. ($2,000.)

rey (tug).—In service. Repairs incident to continuous service.)

nt (iron-clad).—Well preserved. To fit for service. ($2,000.)

icket (iron-clad).—In good condition. To fit for service. ($2,000.)

(tug).—In service. Repairs incident to service. ($1,000).

York (1st rate).—Requires new machinery and new boilers (now l) to be erected on board the vessel at the New York navy- $60,000.)

(tug).—In service. In good condition.

c (3d rate).—In service. Will require shortly general overhaul- repair, with new crank-shaft. ($15,000.)

a (2d rate).—In service. In good condition.

e (3d rate).—In service. In good condition.

(4th rate).—In service. Will shortly require general overhaul- repair, with new boilers. ($28,000.)

c (iron-clad).—In good condition. In service at the United naval Academy. Small repairs. ($2,000.)

ola (2d rate).—In service. In good condition.

(4th rate).—In service. In good condition.

(2d rate).—In service. Boilers in bad condition. Re- rough overhauling and repairs, with new boilers (material on),000.)

Quinnebaug (3d rate).—In service. During the next fiscal year will require to be thoroughly overhauled and repaired, with new boilers. ($75,000.)

Ranger (3d rate).—In service. In good condition. Repairs incident to continuous service. ($10,000.)

Rescue (tug).—In service. Small repairs required. ($500.)

Richmond (2d rate).—Undergoing general overhauling and repairs. Now having new boilers put in at the New York navy-yard. ($35,000.)

Rocket (tug).—In service. In good condition.

Saugus (iron-clad). If ordered for sea service would require to have machinery repaired, and new boilers. ($40,000.)

Shenandoah (2d rate).—In service. In fair condition. Will shortly require thorough overhauling and repair, and new boilers. ($75,000.)

Speedwell (tug).—In service. In good condition. Repairs incident to continuous service. ($2,000.)

Standish (tug).—In service. In good condition.

Swatara (3d rate).—In service. Will soon have to be thoroughly overhauled and repaired, and new boilers (on hand) put in. ($20,000.)

Tallapoosa (4th rate).—Has been thoroughly repaired since being sunk, and is ready for service.

Tennessee (1st rate).—In service. To thoroughly fit for efficient sea service would require extensive repairs, with new boilers. ($85,000.)

Trenton (2d rate).—In service. Repairs incident to continuous service. ($16,000.)

Triana (tug).—Requires thorough repair and new boilers. ($15,000.)

Vandalia (2d rate).—Thorough overhauling and repairs, with new boilers, nearly completed at the Portsmouth navy-yard.

Wabash (1st rate).—In service as receiving ship, Boston navy-yard. If ordered for sea service, would have to be thoroughly overhauled and repaired, with new boilers. ($50,000.)

Wyandotte (iron-clad).—Ready for service.

Yantic (3d rate).—In service. Requires thorough overhauling and repairs. ($8,000.)

DOUBLE-TURRETED MONITORS.

Amphitrite (3d rate).—Under contract with the Harlan and Hollingsworth Company. Will require about seven months to complete, working full force.

Miantonomoh (3d rate).—Engines, &c., in good condition. Requires to have turret machinery (just completed at the Washington navy-yard) put in. ($5,000.)

Monadnock (3d rate).—Boilers completed, and at the Mare Island navy-yard, waiting appropriation to build engines, put in boilers, and fit for sea service. ($210,000.)

Puritan (3d rate).—Under contract with John Roach. Engines, &c., completed and ready for service. Drainage and ventilating system nearly completed.

Terror (3d rate).—Under contract with Wm. Cramp & Sons. Will require about four months to complete, working full force.

NAVY-YARDS.

As no significant alterations have been made in the steam-engineering plant of the several navy-yards, or any considerable additions to it during the past year, little need be said here in relation to it more than to refer to the recommendations of previous reports of the Bureau and

of the late Commission on Navy-Yards, particularly regarding the necessity for a new boiler-shop at the New York navy-yard, the building of which is most earnestly urged.

This Bureau has yielded a large portion of its shop area and tools at the Washington navy-yard for ordnance purposes, and also afforded facilities for same purposes at the Boston navy-yard.

The floating derrick, referred to in my last report, was, on examination, found to be so thoroughly defective in all its parts that it was decided to build a new one entire, of steel; and a contract has been entered into with the Pusey and Jones Company, of Wilmington, Del., for its construction. When completed it will be a most useful appendage to the New York navy-yard for handling heavy weights.

The following is a schedule of the bids for building this floating derrick, under advertisement dated May 19, 1885:

Jacob A. Cole, Brooklyn, N. Y	$74,440
*The Pusey and Jones Company, Wilmington, Del	60,680
The Harlan and Hollingsworth Company, Wilmington, Del	92,000
John H. Dialogue, Camden, N. J	66,286

ESTIMATES OF APPROPRIATIONS.

I have the honor to submit herewith the annual estimates of this Bureau for the fiscal year ending June 30, 1887.

The estimate for steam-machinery has been given more in detail than heretofore; and that for civil establishment specifically estimates for the civilian employés in the steam-engineering department of the several navy-yards, other than those employed as ordinary mechanics and workingmen, and exhibits the amounts paid to such employés during the fiscal year ending June 30, 1885, as required by section 3 (naval appropriation) act of Congress approved January 30, 1885.

Very respectfully,

CHAS. H. LORING,
Chief of Bureau.

Hon. WILLIAM C. WHITNEY,
Secretary of the Navy.

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* Contract awarded June 24, 1885.

Estimates of appropriations required for the service of the fiscal year ending June 30, 1887, by the Bureau of Steam-Engineering, Navy Department.

General object of expenditure, and explanations.		Estimated amount which will be required for each detailed object of expenditure.	Amount appropriated for the current fiscal year, ending June 30, 1886.
SALARIES.			
Chief clerk (March 3, 1885, 23 R. S., p. 70, sec. 416; p. 415, sec. 1)		$1,800 00	
Chief draughtsman (same acts)		2,250 00	
Assistant draughtsman (same acts)		1,400 00	
Two clerks of class two (same acts)		2,800 00	
One clerk of class one (same acts)		1,200 00	
One assistant draughtsman		1,000 00	
One assistant messenger (March 3, 1885)		720 00	
Two laborers (same acts)		1,320 00	
		12,490 00	$12,490 00
NOTE.—Anticipating work in the draughting-room of the Bureau on designs for machinery of the new-cruisers, it is respectfully submitted that there should be appropriated for—			
One assistant draughtsman	$1,200 00		
Without this there can be no lawful increase of the present civilian employés in the draughting-room.			
STEAM-MACHINERY.			
For completion and repairs of machinery and boilers of naval vessels, including cost of new boilers, steam-steerers, steam-capstans, steam-windlasses, &c. (act approved March 3, 1885)		450,000 00	
For preservation of, and small repairs to, machinery and boilers in vessels in ordinary, receiving and training vessels, repair and care of machinery of yard tugs and launches, &c. (act approved March 3, 1885)		40,000 00	
For purchase, handling, and preservation of all materials and stores (act approved March 3, 1885)		200,000 00	
For purchase, fitting, and repair and preservation of machinery and tools in the navy-yards and stations, running yard engines, &c. (act approved March 3, 1885)		125,000 00	
For incidental expenses for naval vessels, yards, and the Bureau; such as foreign postage, telegrams, advertising, freight, photographing, books, stationery, and instruments (act approved March 3, 1885)		25,000 00	
		840 000 00	950,000 00
CONTINGENT.			
Draughting materials, instruments, &c., for the draughting-room (March 3, 1885)		500 00	1,000 00
INCREASE OF THE NAVY STEAM-MACHINERY.			
For steam-machinery of new vessels, types and dimensions to be determined hereafter (submitted)		3,750,000 00	
For completion and erection of engines, &c., connect with boilers, and make ready for sea service in U. S. ironclad Monadnock, at Mare Island, Cal., navy-yard (submitted)		206,000 00	
CIVIL ESTABLISHMENT.			
Navy-yard, Portsmouth, N. H. (March 3, 1885):			
One clerk to department, per annum	$1,200 00		
One store clerk, per annum	1,000 00		
One assistant draughtsman, per annum	1,000 00		
One messenger, per annum	550 00		
		3,850 00	3,708 96
Navy-yard, Boston, Mass. (March 3, 1885):			
One clerk to department, per annum	1,200 00		
		1,200 00	1,199 97
Navy-yard, Brooklyn, N. Y. (March 3, 1885):			
One clerk to department, per annum	1,400 00		
One store clerk, per annum	1,200 00		
One draughtsman, per annum	1,500 00		
One writer, per annum	1,000 00		
One receiver and weigher, per annum	1,000 00		
Two messengers ($600 each)	1,200 00		
		7,300 00	7,525 66

Estimates of appropriations required for the service of the fiscal year, &c.—Continued.

General object of expenditure, and explanations.		Estimated amount which will be required for each detailed object of expenditure.	Amount appropriated for the current fiscal year, ending June 30, 1886.
CIVIL ESTABLISHMENT—continued.			
Navy-yard, League Island, Pa. (March 3, 1885):			
One clerk to department, per annum	$1,200 00		
		$1,200 00	$1,200 00
Navy yard, Washington, D. C. (March 3, 1885):			
One clerk to department, per annum	1,200 00		
One store clerk, per annum	1,100 00		
One draughtsman, per annum	1,500 00		
One messenger, per annum	550 00		
		4,350 00	4,457 7
Navy-yard, Norfolk, Va. (March 3, 1885):			
One clerk to department, per annum	1,300 00		
One store clerk, per annum	1,100 00		
One assistant draughtsman, per annum	1,100 00		
One receiver and weigher, per annum	800 00		
Two messengers ($550 each)	1,100 00		
		5,400 00	4,426 28
Navy-yard, Pensacola, Fla. (March 3, 1885):			
One clerk to department, per annum	1,017 25		
		1,017 25	1,017 25
Navy-yard, Mare Island, Cal (March 3, 1885).			
One clerk to department, per annum	1,400 00		
One store clerk, per annum	1,300 00		
One draughtsman, per annum	1,600 00		
One writer, per annum	1,100 00		
One receiver and weigher, per annum	1,000 00		
One messenger, per annum	600 00		
		7,000 00	5,988 54
		31,317 25	29,519 42

NOTE.—The total amount appropriated for civil establishment, for fiscal year ending June 30, 1886, was $10,000. From this appropriation the "clerks to departments" only at the several navy-yards have been paid, while all the others enumerated above have been and are now paid from appropriation "steam-machinery," but are hereby specifically estimated for under "civil establishment," in accordance with act approved January 30, 1885, section 3.

No. 9.—BUREAU OF PROVISIONS AND CLOTHING.

Statement of appropriations for, and operations of, the Bureau of Provisions and Clothing for the fiscal year ended June 30, 1885.

PROVISIONS.

Amount expended by pay officers abroad:		
For commuted rations to officers	$77, 961 34	
For commuted rations to crews	313, 996 26	
For commuted rations to marines	27, 769 80	
For provisions purchased (including water)	330,470 49	
For freight, labor, and expenses of storehouses	7, 437 84	
		$757, 635 73
Amount of commuted rations stopped on account of sick in hospital and credited to the hospital fund	11, 986 69	
		11, 986 69
Amount expended by Bureau:		
For commuted rations to officers	22, 621 34	
For commuted rations to crews	4, 608 06	
For provisions purchased (including water)	297, 631 36	
For freight, labor, and expenses of inspections	79, 332 65	
		404, 193 41
		1, 173, 815 83
Amount appropriated for the year	1, 100, 000 00	
Deficiency, overpayment from general account of advances	73, 815 83	
		1, 173, 815 83

CLOTHING FUND.

Balance on hand July 1, 1884	462, 689 03	
Amount transferred from general account of advances to the clothing fund on account of issues on board ships during the fiscal years 1883–'84 and 1884–'85	236, 095 31	
Amount received from sales of clothing	39, 593 11	
Total amount received under clothing		738, 377 45
Amount transferred from the clothing fund to general account of advances on account of purchases by pay officers abroad during the fiscal years 1883–'84 and 1884–'85	11, 042 92	
Amount expended by the Bureau, as per requisitions	164, 640 31	
Total amount expended		175, 683 23
Balance on hand July 1, 1885		562, 694 22
Amount transferred from the clothing fund to general account of advances on account of purchases by pay officers abroad during the fiscal year 1884–'85	11, 042 92	
Cost of clothing issued on board ships during the fiscal year 1884–'85	205, 098 77	
		216, 141 69
Cost of clothing purchased by pay officers abroad and paid for from general account of advances during the fiscal year 1884–'85	14, 676 63	
Amount transferred from general account of advances to the clothing fund, on account of issues on board ships during the fiscal year 1884–'85	167, 356 90	
		182, 033 53
Balance due the clothing fund on account of the fiscal year 1884–'85		34, 108 16

SMALL STORES FUND.

Balance on hand July 1, 1884	$160, 709 13	
Amount transferred from general account of advances to the small stores fund on account of issues on board ships during the fiscal years 1883–'84 and 1884–'85	78, 119 43	
Amount received from sales of small stores	3, 253 93	
Total amount received		$242, 082 49
Amount transferred from the small stores fund to the general account of advances on account of purchases by pay officers abroad during the fiscal years 1883–'84 and 1884–'85	8, 189 15	
Amount expended by the Bureau, as per requisitions	66, 982 89	
Total amount expended		75, 172 04
Balance on hand July 1, 1885		166, 910 45

Amount transferred from the small stores fund to general account of advances on account of purchases by pay officers abroad during the fiscal year 1884–'85	8, 189 15	
Cost of small stores issued on board ships during the fiscal year 1884–'85	70, 093 54	
		78, 282 69
Cost of small stores purchased by pay officers abroad and paid for from general account of advances during the fiscal year 1884–'85	14, 389 07	
Amount transferred from general account of advances to the small stores fund on account of issues on board ships during the fiscal year 1884–'85	53, 702 29	
		68, 091 36
Balance due the small stores fund on account of the fiscal year 1884–'85		10, 191 33

CONTINGENT.

Amount appropriated		35, 000 00
Amount expended by Bureau	26, 884 71	
Amount expended by pay officers abroad	6, 633 88	
		33, 518 59
Balance unexpended		1, 481 41

CIVIL ESTABLISHMENT.

Amount appropriated	6, 000 00
Amount expended	6, 000 00

Statement of the cost of stores at the several navy-yards and stations, pertaining to the Bureau of Provisions and Clothing, on hand July 1, 1884; *received and expended during the fiscal year ended June* 30, 1885, *and on hand June* 30, 1885.

	Provisions.	Clothing.	Small stores.	Contingent.
On hand July 1, 1884	$130, 298 24	$593, 559 16	$84, 104 67	$25, 800 66
Receipts fiscal year 1884–'85	330, 166 93	218, 984 42	61, 285 85	15, 323 01
On hand and received	460, 465 17	812, 543 58	145, 390 52	41, 123 67
Expended fiscal year 1884–'85	270, 727 88	279, 049 30	56, 366 30	14, 092 74
On hand June 30, 1885	189, 737 29	533, 494 28	89, 024 22	27, 030 93

Amount paid by the Bureau to employés other than mechanics and laborers during the fiscal year ended June 30, 1885, for the expenses of the inspections of provisions and clothing, in the receipt and care of stores, and for the expenses of the pay offices of the several navy-yards, from the appropriation "Civil Establishment"	$6,000
Appropriation "Provisions"	27,520
	33,520

Amount paid by the Bureau to mechanics, laborers, and others during the fiscal year ended June 30, 1885, for the expenses of the inspections of provisions and clothing, in the receipt and care of stores, and for the expenses of the pay offices of the several navy-yards, from the appropriation "Provisions"	70,651

Estimates of appropriations required for the service of the fiscal year ending June 30, 1887, the Bureau Provisions and Clothing.

General object of expenditure, and explanations.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the current fiscal year ending June 30, 1886.
A.—EXPENSES OF THE BUREAU OF PROVISIONS AND CLOTHING			
For salary of chief clerk (July 5, 1862, 12 R. S., p. 511, sec. 3)	$1,800 00		
For salary of one clerk class four (July 23, 1866, 14 R. S., p. 208, sec. 8)	1,800 00		
For salary of two clerks class three (July 23, 1866, 14 R. S., p. 208, sec. 8)	3,200 00		
For salary of two clerks class two (July 23, 1866, 14 R. S., p. 208, sec. 8)	2,800 00		
For salary of three clerks class one (July 23, 1866, 14 R. S., p. 208, sec. 8)	3,600 00		
For salary of one clerk class one (March 3, 1885)	1,200 00		
For salary of two copyists (March 3, 1885)	1,800 00		
For salary of one messenger (March 3, 1885)	720 00		
For salary of one laborer (March 3, 1885)	660 00		
		$17,580 00	
B.—PROVISIONS NAVY, BUREAU PROVISIONS AND CLOTHING.			
For commutation of rations for 343 naval cadets and 757 officers on sea duty, 401,500 rations, at 30 cents	120,450 00		
For rations and commutation of rations for 8,250 men and boys and 1,000 marines, 3,376,250 rations, at 30 cents	1,012,875 00		
For commuted ration, stopped on account of sick in hospital and credited to the hospital fund	13,500 00		
For water for drinking and cooking purposes on board ships	15,000 00		
For labor and expenses of inspections (March 3, 1885)	60,000 00		
		1,231,825 00	1,0[illegible]

NOTE.—Amount appropriated for the fiscal year 1885		$1,100,000 00
Balance on hand July 1, 1885	$116,020 28	
Indebtedness outstanding against said balance July 1, 1885	186,939 05	
Amount overpaid, account fiscal year 1885	70,918 77	

Which accounts for so much of the increase of $136,000 over the amount appropriated for the current year.

The estimate is based on the number of cadets allowed at the Naval Academy, on the number of men and boys allowed by law, and on the number of officers and marines on duty on board ships entitled to ration, as per the returns to the Bureau, which estimate, $1,133,325, is larger than the whole amount appropriated for the current year.

The amounts asked for for commutation of rations of sick in hospital, for water and for labor and expenses of inspections, are based on the expenditure for the previous year; deducting $25,000 from the latter which is added to the estimates under "civil establishment," Sheet E, in compliance with section 3 act of Congress No. 19, approved January 30, 1885.

s of appropriations required for the service of the fiscal year, &c.—Continued.

l object of expenditure, and explanations.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation	Amount appropriated for the current fiscal year, ending June 30, 1886.
ONS NAVY, BUREAU PROVISIONS AND CLOTHING —Continued.			
the estimate for next year is greater than the ›ropriated for the current year, it is less than e for the current year On what data the ›ropriated was based the Bureau is not in-			
NGENT, BUREAU OF PROVISIONS AND CLOTHING.			
›n shipments, candles, fuel, books and blanks, , advertising, furniture for inspections and pay ›avy-yards, expenses of naval clothing factory, ›stage telegrams, express charges, tolls, ferri- ›ckets, yeomen's stores, iron safes, newspapers, her expenses not enumerated (March 3, 1885)	$60,000 00		$50,000 00
Amount appropriated for fiscal year 1885,			
hand July 1, 1885 ... $6,524 12			
›s outstanding against said balance.. 5,042 71			
ce now on hand ... 1,481 41			
the amount appropriated for the year 1885 was ›r that year, as shown above, there was ex- the year 1884 the sum of $37,663.40 out of the ›n of $40,000 for that year To these expendi- ›e added the freight on provisions, heretofore the appropriation "provisions," estimated at now chargeable to the appropriation "con- Adding this $15,000 to the expenditures, as l, will make $52,663 40, and $48,516.59 for the 1883-'84 and 1884-'85, respectively.			
›STABLISHMENT, BUREAU OF PROVISIONS AND CLOTHING.			
Portsmouth, N. H.:			
man, per diem $2	626 00	$626 00	
Boston, Mass.:			
ter in pay office, per annum	1,017 25		
ter in inspection, per annum	1,017 25		
eivers in inspection, per diem $3	1,878 00		
man in inspection, per diem $2.26	707 38		
		4,619 88	
New York:			
ter in pay office, per annum	1,017 25		
ter in pay office, per annum	939 00		
›senger in pay office, per diem $2 50	782 50		
ter in inspection, per annum	1,017 25		
›senger in inspection, per diem $2.50	782 50		
›ceivers in inspection per diem $4	3,756 00		
›stant receiver in inspection per diem $3.50	1,095 50		
ding men in inspection per diem $2 50	1,565 00		
ressmen in inspection, per diem $2 76	6,047 16		
tendent coffee and spice mill inspection, per 3	939 00		
ker, inspection, per diem $3	939 00		
›aster, per diem $2.50	782 50		
tender, per diem $3.26	1,020 38		
›, per diem $2	626 00		
›r, per diem $2.50	782 50		
		22,091 04	
Washington, D. C.:			
ter in pay office, per annum	1,300 00		
ne operator, pro rata	225 00		
		1,525 00	
Norfolk, Va.:			
ter in pay office, per annum	1,017 25		
ter in inspection, per annum	1,017 25		
›iver in inspection, per diem $3	939 00		
›stant receiver in inspection, per diem $2.50	782 50		
		3,756 00	

Estimates af appropriations required for the service of the fiscal year, &c.—Continue

General object of expenditure, and explanations.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the current fiscal year.
D.—CIVIL ESTABLISHMENT, BUREAU OF PROVISIONS AND CLOTHING—Continued.			
Navy-yard, Mare Island, Cal.:			
One writer in pay office, per annum	$1,017 25		
One writer in inspection, per annum	1,017 25		
		$2,034 50	
		34,652 92	
Naval clothing factory, New York:			
One cutter, per annum	1,800 00		
One machine operator, per diem $3.50	1,095 50		
One writer, per diem $3.25	1,017 25		
Two laborers, each per diem $2.26	1,414 76		
		5,327 51	
		39,980 43	

NOTE.—The $6,000 appropriated under "civil establishment" for the fiscal year 1885 was paid to the writers in the pay offices of the yards at Boston, New York, Washington, and Norfolk, and for a portion of the year to the writers in the inspections of provisions and clothing at the yards at Boston and New York; and the amount appropriated for the current fiscal year, $6,000, will be expended for the same purpose.

All of the positions "other than mechanics and laborers," for which estimates are submitted, are now filled, except the firemen at the navy-yards, Portsmouth and Boston, who are employed only when fires are necessary, and the telephone operator at the navy-yard, Washington, who is paid by this Bureau for a portion of the year only, and the employés are paid from the appropriation "Provisions," except the writers referred to above.

The amount paid to these employés from the appropriation "Provisions," for the fiscal year 1885, for the number of days only actually employed was $27,520.72.

This estimate is for an annual salary for the writers, and for a per diem for 313 days for the remaining force; and is made in accordance with section 3 of the act of Congress No. 19, approved January 30, 1885.

* Previous estimates did not embrace this number of clerks in civil establishment.

Schedule of proposals for fresh provisions, navy bread, baking, and water received duri fiscal year ending June 30, 1884, the supplies to be delivered during the fiscal year 1884-

Name.	Where to be delivered.	Fresh bread.	Fresh beef.	Vegetables.	Navy bread.	Baking flour.
		Per lb.	*Per lb.*	*Per lb.*	*Per lb.*	*Per bbl.*
James E. Chase*	Portsmouth, N. H	$0 05.49	$0 09.49	$0 01.50		
B. F. Muridge	do	08	11.50	01.50		
John Holland	do	06	11.75	01.75		
J. W. Hobbs*	Boston, Mass		13¼	04		
C. H. Flanders & Co	do		15¼	04¼		
H. P. Stevens	do		17	02¼		
Austin & Graves*	do	06				$1.75
John Hanley	New York, N. Y		10¼	02		
John G. Allport & Co	do		10¼	02		
James J. Lyons †	do		10.60	02.90		
C. Desmond †	do		11	02¼		
Patrick Sullivan †	do		09¾	01¾		
John G. Burns †	do	03¼				
James Godfrey †	do	06¼				
Frank Fruin	do	06¼				
John McNamara*	do	06¼				
E. Treadwell's Son	do					1 17
C. T. Goodwin & Son*	do					89

* Contract awarded. † Informal bids.

Schedule of proposals for fresh provisions, navy bread, baking, &c.—Continued.

Name.	Where to be delivered.	Fresh bread.	Fresh beef.	Vegetables.	Navy bread.	Baking flour.	Water.
		Per lb.	*Per lb.*	*Per lb.*	*Per lb.*	*Per bbl.*	*Per gal.*
..n Hartman*	League Island, Pa					$1 40	
Strohmaier*	do	$0 05¼					
S. Boraef*	do		$0 12½	$$ 04			
Heuizerling	Washington, D. C	03.85					
..ller & Ginzer†	do	03⅛					
G. Alexander	do		09.99	03¼			
Charlton & Co*	do	03¾				1 50	
C. Carroll*	do		09¾	03			
..orge Seitz & Son†	do	03.90					
..ac Gutman*	Norfolk, Va		06.13	01¼			
B. Kimberly	do	05¼	10.73	03¾			
..orge Berry	do		06.85	01.33			
..bert Searls	do		08.45	02¼			
..ank Dusch	do		06.65	01.70			
Westheimer	do		06.66	01.95			
G. Codd A Bro	do		07.10	02.10			
..uis Wasserman	do		06.45	01.75			
..mes Reid & Co*	do					2 00	
Cabler*	do	04⅛					
..illiam Clark *	do						$0 00⅛
..illiam Clark *	Fortress Monroe, Va						01
B. Kimberly *	do	04½					
T. Cabler	do	04.37½					
..B. Bell*	Pensacola, Fla		16	07			
O'Neal *	do				$0 06⅛		
..ses White *	do	06					
Neuman	Mare Island, Cal		14	03½			
..n Faust *	do	05					
F. Tobin *	do		10.9	02¾			
..ifornia Cracker Co *	do				04.4		
T. Brown, jr	do				05⅛		
..ipse Cracker Co	do				04.45		

* Contract awarded. † Informal bids.

..edule of proposals for 3,000 *yards cloth for caps under Bureau's advertisement dated July* 9, 1884.

Y. Pippey & Co., per yard *$2 07

* Contract awarded.

..chedule of proposals for small stores under Bureau's advertisement dated July 21, 1884.

Names.	3,000 razors.	5,000 papers needles.	10,000 dozen eagle buttons.	1,000 mess-kettles.	500 mess-pans.	5,000 spoons.
	Each.	*P'r paper.*	*Per doz.*	*Each.*	*Each.*	*Each.*
... Walker	$0 29			†$0 49	$0 39	$0 02½
... H. Creed	27			51	37	02.4
A. Wheeler*	1 25	$0 03.8	$0 22½	*†49	39	02.8
T. Wakeman*	37 5/12	04 / 03	22	58	35	*‡2 35
P. Brown*	24	*†02	22¾	49½	39½	02¾
... Michael*	*23	†02	*2 39	†49	*35	‡2 87
A. Robbins	§22 / ‖26¾		21.8	49.9	36.9	02.4
A. Watson	No. 1 31½ / No. 2 31					

* Contract awarded. † Tie bids; decided by lot. ‡ Per gross. § Bond. ‖ Duty paid.

Schedule of proposals for Navy supplies under Bureau's advertisement dated July

Name.	800 barrels pork.	10,000 pounds evaporated apples.	10,000 gallons [illegible]
	Per bbl.	Per lb.	Per gal.
R. A Robbins	$20 67		
J. W. Buker	17 74	$0 16.9	[illegible]
A. P. Brown	18 43	†13	[illegible]
David Babcock & Co	18 47		
W. A Wheeler	19 70	18	[illegible]
J. R. Michael*	*17 38	*†13	

* Contract awarded. † Tie bids, decided by lot. ‡ Per bushel.

Schedule of proposals for Navy supplies under Bureau's advertisement dated Se[illegible] 1884.

Names.	1,500 barrels beef	3,500 barrels pork.	120,000 pounds preserved meat.	50,000 pounds rice.	60,000 pounds pickles.	50,000 pounds tomatoes.	300,000 pounds sugar.
	Per bbl.	Per bbl.	Per lb.	Per lb.	Per lb.	Per lb.	Per [illegible]
A. P. Brown†	$15 93	$16 43	$0 09.9	$0 05¼	$0 05.7	$0 03.7	[illegible]
J. R. Michael†		16 14	10.9	06	06.2	03.2	[illegible]
R. A Robbins†	16 50				07		
D. Babcock & Co	16 58	16 29	12.39				
R. M. Masterton†				06.7			[illegible]
C. L. Todd*						*03.16	
F. Foehrenback & Co*					*06		
F. B. Thurber*	*13 99	*13 99	13.45	*06.10	06.30	04.45	[illegible]
Armour, Plankinton & Co*		whole, 17 00; half, 9 00	(‡)				
J. H. Jahn				06¼			
Rossiter, Skidmore & Co	15 68	16 48	11.48				
J. W. Buker†					06		

* Contract awarded. † Not considered regular dealers. ‡ $4.75 per dozen [illegible]

Names.	10,000 gallons vinegar	6,000 yards blue cloth, trousers.	30,000 yards 6-4 11-oz. flannel.	5,000 yards Barnsley sheeting.	6,000 pairs calf shoes.	8,000 pairs kip shoes.	10,000 pairs woolen socks.
	Per gal.	Per yard.	Per yard.	Per yard.	Per pair.	Per pair.	Per pair.
Thomas Kent			‡$0 83.9; ‖87				
A. P. Brown†	$0 11	$1 85	89	$0 87	$2 03	$2 09	[illegible]
J. R. Michael†	13			59½	2 09	2 12	
R. A. Robbins†				71			
Woodward & Lothrop				60			
Dean Woolen Company*		*1 79.94					
William McKnight					2 15	2 10	
O. W. Hayes				58½			
J. Freeman & Co*					*1 99	*2 10	
George H Creed†				61½			
H. H. Tobey†				54½			[illegible]
G. P. Ockershausen	15 90						
F. Foehrenback & Co*	*15						
F. B. Thurber	16½						
H. Smith*				*57½			
B. Y. Pippey & Co*		1 86	*81.9	59½			*[illegible]7.1
J. W. Buker†	14½			59½			

* Contract awarded. † Not considered regular dealers. ‡ For 11,900 yards. ‖ For 18,100 yards.

ames.	5,000 blankets.	50,000 yards cotton duck.	100,000 pounds salt-water soap	5,000 pocket handkerchiefs.	5,000 wisp brooms.	5,000 boxes blacking.	75,000 pounds candles.
	Each.	Per yard.	Per lb.	Each.	Each.	Each.	Per lb.
†	$1 95	$0 10.37	$0 3.59	$0 07½	$0 07¼	$0 02.69	$0 11.4
ll..							13.90
†	2 25	10	03.7	07½	09.74	02½	12.9
e†		10.85	03.85		11	02.7	
& Co.		12¾			09.9	*4 38	
n & Co*..		*10.96					
			03.7				
k Bro*.						*08½	
eed †		10.7			10		
†.	2 08	10.26		15½	14		
il Company *							*12½
					**1 30	††4 95	
& Co..				12½	12½	03½	
ard					13½		
ne..			03.80				
ner	2 03½						
r*			*03.7			04½	14.28
					12½		
			03.97				
					*09¾		
				*10¾			
& Co *	*1 98						

‡ awarded. † Not considered regular dealers. ** Per gross. †† Per dozen.

proposals for 100,000 *pounds tobacco under Bureau's advertisement dated February* 4, 1885.

Names.	100,000 pounds tobacco, per pound.	
	No. 1	No. 2
	Cents.	Cents.
obacco Company†	24½	29
& Co	50	
ner	40	
hanan*	$28\frac{83}{100}$	
& Co	28	

* Contract awarded. † Not equal to standard.

proposals for Navy supplies under Bureau's advertisement dated March **16, 1885.**

Names.	10,000 pounds apples.	10,000 gallons beans.	60,000 yards ¾ flannel.	10,000 B. S. neckerchiefs.	5,000 scissors.	2,000 razor-strops.
	Per lb.	Per gall.	Per yard.	Each.	Each.	Each.
e	$0 10					
Pioneer Woolen Factory			$0 89			
Mills				$0 93		
Co.	*9⅞	$0 25⅞				
hael				*75.9		
& Co			86.74			
l..	9.9	24.4				
l			*65			
	11.49	24.49				
			85			
				1 06		
	10.2	*23.9				
ll.					*$0 18	*$0 17$\frac{11}{12}$
			†84			
					25.99	
				83		

* Contract awarded. † Informal.

Schedule of proposals for 100,000 pounds coffee under Bureau's advertisement dated April 28, 1885.

Wood & Acklin	per pound	$0 11
J. R. Michael	do	08.38
Thurbur, Whyland & Co*	do	08.61
R. A. Robbins	do	08.90

* Contract awarded.

Schedule of proposals for fresh beef and vegetables and fresh bread for United States Naval Academy, Annapolis, Md., for fiscal year ending June 30, 1885.

Names.	Fresh beef.	Fresh vegetables.	Fresh bread.
	Per pound.	*Per pound.*	*Per pound.*
John Kealy	$0 09¾	$0 03¾	
Martin M. Smith*			$0 04¾
Jackson Brewer*	09	04	
Alex. Heyse			04
Lindenborn & Bro			04

* Contracts awarded.

Schedule of proposals for fresh beef and vegetables, fresh bread and water, United States Naval Station, Newport, R. I., for the fiscal year ending June 30, 1885.

Names.	Fresh beef.	Fresh vegetables.	Fresh bread.
	Per pound.	*Per pound.*	*Per pound.*
Simeon Davis			$0 04¾
William S. Bailey	$0 12¾	$0 03	04¾
Lawton Coggeshall*	12¾	02¾	04¾

* Contracts awarded.

Statement of contracts made by the Bureau of Provisions and Clothing for and in behalf of the Navy Department during the fiscal year ending June 30, 1885.

Name.	Date.		Articles contracted for.		Price.	Where to be delivered.
	1884.					
Austin & Graves	July	1	Baking flour	per bbl.	$1 75	Boston, Mass.
Do	July	1	Fresh bread	per lb.	06	Do.
J. W. Hobbs	July	1	Fresh beef	do	13¼	Do.
Do	July	1	Vegetables	do	04	Do.
John Hanley	July	1	Fresh beef	do	10½	New York, N. Y.
Do	July	1	Vegetables	do	02	Do.
J. McNamara	July	1	Fresh bread	do	06¼	Do.
C. T. Goodwin & Son	July	1	Baking flour	per bbl.	89¾	Do.
John S. Bell	July	1	Fresh beef	per lb	16	Pensacola, Fla.
Do	July	1	Vegetables	do	07	Do.
J. O'Neal	July	1	Navy bread	do	06½	Do.
California Cracker Co	July	1	do	do	04⅞	Mare Island, Cal.
C. Strohmaier	July	1	Fresh bread	do	05¼	League Island, Pa.
Moses White	July	1	do	do	06	Pensacola, Fla.
C. T. Cabler	July	2	do	do	04½	Norfolk, Va.
J. Reid & Co	July	2	Baking flour	per bbl	2 00	Do.
J. B. Kimberly	July	2	Fresh bread	per lb	04¼	Fortress Monroe, Va.
J. F. Tobin	July	2	Fresh beef	do	10⅝	Mare Island, Cal.
Do	July	2	Vegetables	do	02¾	Do.
John Faust	July	2	Fresh bread	do	05	Do.
I. Gutman	July	3	Fresh beef	do	06 11/16	Norfolk, Va.
Do	July	3	Vegetables	do	01¼	Do.
C. C. Carroll	July	3	Fresh beef	do	09¾	Washington, D. C.
Do	July	3	Vegetables	do	03	Do.
James E. Chase	July	3	Fresh beef	do	09 13/16	Portsmouth, N. H.
Do	July	3	Vegetables	do	01¾	Do.
Do	July	3	Fresh bread	do	05 13/16	Do.
J. Hartman	July	3	Baking flour	per bbl.	1 40	League Island, Pa.

f contracts made by the Bureau of Provisions and Clothing, &c.—Continued.

ne.	Date.	Articles cantracted for.	Price.	Where to be delivered.
	1884.			
k............	July 5	Juniper water ......per gall.	$0 00½	Norfolk, Va.
....	July 5	......do	01	Fortress Monroe, Va.
....	July 7	Fresh beef............per lb.	12½	League Island, Pa.
....	July 7	Vegetables ....do...	04	Do.
t Co.........	July 8	Fresh bread ....do...	03¾	Washington, D. C.
....	July 8	Baking flour.........per bbl	1 50	Do.
& Co	Aug. 2	Cloth for caps, 3,000 yds., per yd.	2 07	New York, N. Y.
er...........	Aug. 8	Mess kettles, 1,000 .....each.	49	Do.
....	Aug. 11	Razors, 3,000 ....do...	23	Do.
....	Aug. 11	Eagle buttons, 1,000 doz., per gross.	2 39	Do.
....	Aug. 11	Mess pans, 500..........each.	35	Do.
....	Aug. 20	Pork, 800 bbls ... ...per bbl.	17 38	Do.
....	Aug. 20	Beans, 10,000 galls...per gall.	34	Do.
....	Aug. 20	Evaporated apples, 10,000 lbs., per lb.	13	Do.
....	Sept. 17	Coffee, 100,000 lbs .....per lb.	10 3/100	Do.
ı Company..	Oct. 15	Cloth for trousers, 500 yards, per yd.	1 79 24/100	Do.
ınkinton &	Oct. 17	Preserved meat, 120,000 pounds, per lb.	09 838/1000	Do.
: Co.........	Oct. 17	Calf shoes, 6,000 prs .per pr..	1 99	Do.
....	Oct. 28	Tomatoes, 50,000 pounds, per lb.	03 18/100	Do.
& Co	Nov. 5	Flannel, 6-4, 11-ounce 30,000 yards, per yd.	81 9/10	Do.
....	Nov. 5	Blankets, 5,000 ....each..	1 93	Do.
t Bro........	Nov. 24	Blacking, 5,000 boxes..each..	03½	Do.
)il Company.	Nov. 26	Candles, 75,000 pounds. per lb.	13½	Do.
r............	Nov. 28	Beef, 1,500 barrels.. per bbl..	13 99	Do.
....	Nov. 28	Pork 2,500 barrels ......do...	13 99	Do.
....	Nov. 28	Rice, 50,000 pounds..per lb..	06 1/10	Do.
....	Nov. 28	Sugar, 200,000 pounds...do...	06 24/100	Do.
r............	Nov. 28	Salt-water soap, 100,000 pounds, per lb.	08 7/10	Do.
....	Nov. 29	Pocket handkerchiefs, 5,000, each.	10⅞	Do.
& Co	Dec. 2	Woolen socks, 15,000 pairs, per pr.	27 7/10	Do.
: Co.........	Dec. 3	Kip shoes, 3,000 pairs. per pr..	2 10	Do.
ıch & Co....	Dec. 4	Pickles, 60,000 pounds. per lb .	06	Do.
....	Dec. 4	Vinegar, 10,000 gallons, per gall.	15	Do.
....	Dec. 8	Wisp brooms, 5,000....each..	09¾	Do.
ın & Co	Dec. 27	Cotton duck, 50,000 yards, per yd.	10 29/100	Do.
ı	Dec. 29	Barnesly sheeting (bond), 5,000 yards, per yd.	57½	Do.
	1885.			
hanan	Apr. 4	Tobacco, 100,000 pounds, per lb.	26 29/100	Do.
nith.........	Apr. 15	Fresh bread ....per lb.	03½	Annapolis, Md.
wer	Apr. 15	Fresh beef ....do...	09	Do.
....	Apr. 15	Vegetables ....do...	04	Do.
& Co.........	Apr. 20	Evaporated apples, 10,000 pounds, per lb.	09⅞	New York, N. Y.
ıl............	Apr. 22	B. S. neckerchiefs, 10,000, each.	75 9/10	Do.
vell	Apr. 23	Scissors, 5,000 ....each..	18	Do.
....	Apr. 23	Razor-strops, 2,000......do...	17 11/12	Do.
m...........	Apr. 23	Flannel, 6-4, 11-ounce, 60,000 yards, per yd.	85	Do.
ıhall......	Apr. 25	Fresh beef...........per lb..	12½	Newport, R. I.
....	Apr. 25	Vegetables ....do...	2¾	Do.
....	Apr. 25	Fresh bread ....do ..	06	Do.
....	Apr. 25	Water ....per gall..	00½	Do.
y	Apr. 27	Beans, 10,000 gallons...do ..	23 9/10	New York, N. Y.
ayland & Co.	May 21	Coffee, 100,000 pounds. per lb..	08 61/100	Do.
oap M'g Co.	June 9	Salt-water soap, 100,000 pounds, per lb.	3 1/10	Do.

Statement of sales of condemned materials pertaining to the Bureau of Provisions and Clothing during the fiscal year ending June 30, 1885.

Where sold.	To whom sold.	Gross amount of proceeds. Provisions.	Clothing.	Small stores.	Contingent.	Cost of sale.	Net proceeds.
Navy-yard, Portsmouth	Downs & Co., W. J. Hallett, H. Staples, H. C. Russell, L. E. Lunt, W. Muir, Rider & Cotton, J. Holan, Charles Lovell, H. C. Lovell, A. P. Wendall & Co., J. E. Chase, Charles Churchill, J. Sanders, J. Hughes, Mugridge & Co., J. H. Webster, W. A. Gilman, T. J. Sheehan, J. Molan, J. H. Powers, A. Robinson, A. H. Paine, E. C. Neeley, C. L. Hayes, Jos. Harlow, John Chickering.	$163 42	$435 16	$115 76	$101 72	$18 51	$797 55
w York	Dryfuss, Buckley, Bannerman, Brady, Sleigman, Kane, Donovan, Miner, Fleet, Sleigman Bros., Stewart, Lackey, Rider & Cotton, Pray, Cohen, Kerrigan, Allen, Stoddard & Bro., McMahon, Fink, Hallett, Clark, Townsend, William Birch.	1,984 04	2,179 26	188 65	70 50	299 58	4,122 87
	Bannerman, Watts, Parker & Co., Seligman, Allen, Kerrigan, Burris, Lackey, Doughtor, Clapp, Gifford, McMahon, Lepson, Kelly.	422 00	350 30	17 65	1 87	46 59	745 23
[illegible]k	C. Karrigan, McMahon, Lacky, Doughter, Wilson		2,622 64			99 78	2,522 86
on	J. Dryfuss, H. Baum, Springman, S. Beiber, C. A. Smith, W. H. Arnett, Carmon, Meredith, Cash, H. Bernheimer, E. G. Wheeler.	5 06	141 93	9 48	249 05	27 37	378 15
k	Codd & Bro., M. Freidman, Lintz, H. Pincus, M. D. Eastwood, P. Turney, A. A. McCullough, Driefuss, J. C. Sykes, A. Cohen, Landsburg, J. Deggs, A. J. Pool, W. H. Palmer, C. Coles, J. Grant, J. Tischler, Pat O'Connor, J. Foreman.	44 91	1,456 96	1 05	173 00 Empty bbls	49 07	1,626 85
	J. Dreyfus, Charles Hey, J. Woodman, A. C. Freidman, John Melon, O. J. Flemming, O. E. Maltby, M. W. Burke, M. W. Castello, S. Kellum, Thomas Reed, J. A. Denson, S. Kullum, M. Kaufman, D. M. Cherry, S. Freidlin, M. Teschler, W. H. Palmer, J. R. Peaden, T. Hartung, P. Turney, H. Baum, J. C. Brown, J. W. Winindger, J. Woodman, George A. Scott, John Milan, H. E. Culpepper, George Neville, R. W. Morris, M. Fuller, C. Hurst.	336 30	2,719 41	283 42	2 70	183 29	3,158 54
ola	No names given	33 55	175 60	9 65		3 00	215 80
sland	T. Kehoe, J. Malloy, B. Passalagua, J. Wilhnan, J. Aden, C. Hare, A. Powell, J. Ford, C. O'Brien, J. Carman.	84 75	281 06	8 05	4 20	8 64	369 42
	B. Passalaqua, A. S. Carman, C. Hare, T. Kehoe	178 52	524 75	21 10	7 10	34 68	696 79
le Janeiro	No names given	239 61	2,948 40	762 22	591 82	232 08	4,409 47
	No names given (furniture)				40 95	2 05	38 90
d	No names given	77 63		9 60		4 36	82 87
		6 00				30	5 70
	do	100 18	1,308 87	137 29	83 60	157 63	1,466 76
	do				426 62	39 13	387 49
	No names [illegible]n (furniture)	28 09				None	28 09
[illegible]	J. Kepple[illegible]elds, England						

[illegible]	[illegible]						
United States ship Quinnebaug	... Green, Lisbon, Portugal	17 50		3 05		do	[illegible]
United States ship Kearsarge	Frank Joseph, European Station	36 20				do	36 20
United States ship Palos	No names given	4 32				do	4 32
United States ship Monocacy	do	5 98				do	5 98
Navy-yard, New York, Greely relief stores.	McMahon, Bannerman, Lackey, Dryfuss, Hallet, Hoover, Seligman Brothers, Fleet, Graham, Fitzgerald, Jackson, Frazier, Kerrigan, Kane, Allen, Southwick, Townsend, Gladding, Stewart, Nathan, W. James & Co.	2,851 72	8,536 97	15 15	7 50	773 02	10,638 32
Do	Bannerman, Seligman, McMahon, Wilson	585 00				20 36	514 64
Total		7,261 73	28,675 81	1,582 18	1,760 13	1,999 44	32,280 36

No. 10.—MARINE CORPS.

HEADQUARTERS U. S. MARINE CORPS,
COMMANDANT'S OFFICE,
Washington, D. C., October 1, 1885.

SIR: I have the honor to submit my annual report of the condition of the U. S. Marine Corps.

On October 1, 1885, there were 1,880 enlisted men in the Corps, 957 of whom were on board ships in commission, and 923 doing duty at the several shore stations.

During the past year there have been 596 enlistments, 62 re-enlistments, 7 enlistments from the Army, 17 deaths, 312 discharges, 399 desertions, and 9 enlisted men have been retired.

One captain (active list) has died, promoting one first and one second lieutenant. One staff major has been retired, having reached the age provided by law. One captain and assistant quartermaster has been promoted to be major and quartermaster, and one captain has been transferred from the line by appointment to be assistant quartermaster, thus promoting one first and one second lieutenant. One first lieutenant has been retired for disability, promoting one second lieutenant.

Congress having provided at its last session that the Corps shall be reduced to 75 officers on the active list, it is now in process of reduction, there being at present 82 officers.

In April last two battalions, which were assembled from the various shore stations and the receiving and training ships, were suddenly transferred for important duty on the Isthmus of Panama.

The Department has been informed of the satisfactory manner in which this duty was performed and of the creditable conduct of the officers and enlisted men.

I desire to express to the Department my own high appreciation of the prompt, cheerful, and efficient manner in which the officers and men did this duty, which was both arduous and dangerous, as was shown by the loss of several men from an epidemic of yellow fever. A longer stay would have caused great loss of life, which was happily averted.

This expedition has, however, shown in the strongest manner what I have for years stated to the Department, viz, that we have not enough officers and men. All the shore stations were nearly stripped and left without adequate protection.

The guards were withdrawn from numerous ships for the same purpose, resulting in much inconvenience to the service.

It has also shown that the Marine Corps should have a complete outfit of tents and camp equipage for 500 men, as well as woven cartridge belts for use in the field. With the limited appropriations granted us yearly it is impossible to purchase these things, and in a sudden emergency like the one referred to great inconvenience arises.

In my report of last year I referred to the lack of promotion and the

quent hardship resulting. Some of the captains have been 21 in that grade, with no immediate prospect of promotion. Several e first-lieutenants have been twenty years in the service. Unless increase in the higher grades is made and a better distribution of umber of officers allowed this state of affairs must continue, to the discouragement of ambition and professional pride.

gain renew my recommendation that the sum of $12,350 be appro- ed to alter building No. 17, at the Norfolk navy-yard, into a bar- for the enlisted men stationed there. This estimate and plan made by the civil engineer of the yard to meet a long-felt and ute necessity.

e reports of inspections made during the year show a very satis- ry state of discipline and efficiency at all the posts of the Marine s and in the guards of vessels afloat.

increase of 500 privates is urgently needed to make the Corps ughly efficient and give a proper relief to those returning from With the limited number now allowed it becomes necessary to men to ships who have not been long enough in service to be rly instructed as soldiers. They should be one year in garrison r instruction before going to sea.

rked improvement has been made in target practice during the year and the results are very satisfactory.

e estimates for the support of the Corps for the coming fiscal year submitted in duplicate on the 29th ultimo, and I inclose herewith nents, as required in the Department's letter of August 21, in liance with section 429, Revised Statutes.

Very respectfully, your obedient servant,

C. G. MCCAWLEY,
Colonel-Commandant.

n. WM. C. WHITNEY,
Secretary of the Navy, Washington, D. C.

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nt of the amount of appropriation for pay of the Marine Corps for the year ending une 30, 1885, and the amount expended by the paymaster of the Marine Corps.

priation for the year ending June 30, 1885	$653,075 00
amount disbursed by Maj. Green Clay Goodloe, paymaster, United es Marine Corps	425,595 89
Balance	227,479 11

appropriation for pay of the Marine Corps being subject to requisitions drawn officers of the Navy, I cannot state what amount of the entire appropriation unexpended. All marines serving afloat are paid by naval paymasters a por- their pay, and all balances due them on being transferred ashore are paid by

ectfully submitted.

GREEN CLAY GOODLOE,
Major and Paymaster, Marine Corps.

. WILLIAM C. WHITNEY,
Secretary of the Navy.

Estimates of appropriations required for the service of the fiscal year ending June 30, 1887, by the paymaster, United States Marine Corps.

General object of expenditure, and explanations.	Total amount to be appropriated under each head of appropriation.
MARINE CORPS.	
Pay of officers on the active list:	
For one colonel-commandant, one colonel, two lieutenant-colonels, one adjutant and inspector, one paymaster, one quartermaster, four majors, two assistant quartermasters, one judge-advocate-general United States Navy; nineteen captains, thirty first lieutenants and nineteen second lieutenants, per R. S., p. 271, secs. 1396, 1623; June 30, 1834, vol. 4, p. 713, secs. 4, 5; March 2, 1847, vol. 9, p. 153, sec. 8; August 5, 1854, vol. 10, p. 586, sec. 1; February 2, 1857, vol. 11, p. 163, sec. 1; July 17, 1862, vol. 12, p. 594, sec. 2; June 30, 1864, vol. 13, p. 144, sec. 1; March 3, 1865, vol. 13, p. 487, sec. 1; July 28, 1866, vol. 14, p. 334, sec. 37; July 28, 1866, vol. 14, p. 337, sec. 13; March 2, 1867, vol. 14, p. 422, sec. 37; July 15, 1170, vol. 14, p. 517, sec. 1; July 18, 1875, vol. 18, p. 301, sec. 7; Navy Regulations, July 18, 1816	$181,265 00
Pay of officers on the retired list:	
For one colonel, one quartermaster, three majors, two assistant quartermasters, four captains, one first lieutenant, and three second lieutenants	31,240 00
Pay of non-commissioned officers, musicians, and privates:	
For one sergeant-major, one quartermaster-sergeant, one leader of the band, one drum-major, fifty first sergeants, one hundred and forty sergeants, one hundred and eighty corporals, thirty musicians, ninety-six drummers and fifers, and one thousand five hundred privates	389,052 00
Pay of civil force:	
For ten clerks and two messengers, to wit: Four clerks at $1,540.80 per annum; three at $1,496.52, and three at $1,257.12 per annum; one messenger at $971.28 per annum, and one at $1.75 per day	16,085 00
Undrawn clothing:	
For payments to discharged soldiers for clothing undrawn	20,000 00
Transportation:	
For transportation of officers traveling under orders without troops	8,000 00
Commutation of quarters:	
For commutation of quarters for officers on duty without troops	4,000 00
Total	649,642 00

Respectfully submitted.

GREEN CLAY GOODLOE,
Major and Paymaster, Marine Corps.

HEADQUARTERS U. S. MARINE CORPS,
Commandant's Office, September 28, 1885.

Forwarded approved.

C. G. McCAWLEY,
Colonel Commandant, U. S. M. C.

HEADQUARTERS MARINE CORPS, QUARTERMASTER'S OFFICE,
Washington, D. C., September 28, 1885.

have the honor to transmit herewith the annual estimates of appropriations for the service of the fiscal year ending June 30, 1887 by the quartermaster's ent of the Marine Corps.

ectfully call your attention to the fact that these estimates vary from those d for the fiscal year ending June 30, 1886, as follows, viz: Rations are de-3,398.15, based upon the actual contract price of 18 cents per ration, 1885-'86, st 19 cents per ration, fiscal year 1884-'85. Clothing is increased $2,081, in nce of the introduction, by authority of the Navy Department, of a hand-made oe, at an increased cost per pair, in place of the wire-screwed shoe heretofore lso an increase in the number of overcoats to be manufactured, this last item sed upon the number actually issued during the fiscal year 1884-'85. The in-cost of material to be used in manufacturing clothing for fiscal year 1885-'86 t obtained under contract during the fiscal year 1884-'85 makes the increased absolutely necessary.

ecreased $600, based upon the reduction in number of commissioned officers; stores decreased $500; repair of barracks is increased $1,202.

estimates are based upon reports of boards of survey now on file in this office, amounts specified are actually required to preserve this Government prop-to place it in a habitable condition The opening of a depot of supplies at ncisco, Cal., by authority of the Navy Department, has added $480 to the to be expended under the above head.

gent increased $1,066.20, based upon the actual increase paid fiscal year over 1883-'84 at the different ports for water, gas, and straw.

ggregate amount asked for fiscal year ending June 30, 1887, is $269,199.67, 351.11 more than the amounts asked for fiscal year ending June 30, 1886.

spectfully, your obedient servant,

H. B. LOWRY,
Quartermaster, Marine Corps.

OLONEL-COMMANDANT U. S. MARINE CORPS.

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s of appropriations required for the service of the fiscal year ending June 30, 1887 by the Quartermaster's Department, Marine Corps.

eral object of expenditure, and explanations	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the current fiscal year ending June 30, 1886.
PROVISIONS.			
on-commissioned officers, musicians, and privates, , at 1 ration per day is 365 000 rations at 18 cents on, is	$65,700 00		
nce between the cost of rations at 18 cents and ation at $1, for one enlisted man employed as colonel commandant 365 days is 365 rations; at per ration is	299 30		
ence between the cost of rations at 18 cents and ation at 75 cents for 9 enlisted men employed as nd messengers in commandant's, adjutant's, and r's, paymaster's and quartermaster's offices, gton, D. C., and assistant quartermaster's offices, lphia, Pa., and San Francisco, Cal., 365 days, is ions at 57 cents per ration, is	1,872 45		
ence between the cost of rations at 18 cents and ation at 50 cents, for three enlisted men employed 365 days, is 1,095 rations, at 32 cents per ration,	350 40	$68,222 15	$66,000 00
Commutation in lieu of rations in kind, at the 75 and 50 cents, to the above enlisted men, is by order of the Navy Department, 28th June, 0th July, 1885.			

Estimates of appropriations required for the service of the Marine Corps, &c.—Continued.

General object of expenditure, and explanations.	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the current fiscal year ending June 30, 18[illegible]
CLOTHING.			
For 2,000 non-commissioned officers, musicians, and privates, at $36.36 per annum, actual cost	$72,720 00		
800 overcoats, at $7.52 each	6,016 00		
3,000 pairs hand-sewed shoes, at $2.96½ per pair	8,895 00		
		$87,631 00	$77,[illegible]
NOTE.—Hand-sewed shoes to take the place of old pattern. By order Navy Department.			
FUEL.			
For 3,794 cords of wood, as follows: 1 colonel-commandant, 1 colonel, 2 lieutenant-colonels, 4 majors, 3 staff majors, 2 staff captains, 12 captains, 15 first lieutenants, 10 second lieutenants, 1,000 non-commissioned officers, musicians, and privates, 6 hospitals, 1 armory, 5 mess-rooms for officers, 16 offices for commandant and staff and commanding officers of posts, 9 rooms for officers of the day, 9 guard-rooms at barracks and navy yards, 4 stores for clothing and other supplies, one-fourth additional on 2,400 cords, the quantity supposed to be required in latitude north 36 degrees from 1st September to 30th April, 575 cords, amounting in all to 3,794 cords, at $6 per cord	....	22,764 00	[illegible]
MILITARY STORES.			
For pay of one chief armorer, at $3 per day, $939; three mechanics, at $2.50 each per day, $2,347.50, in all	3,286 50		
For purchase of military equipments, such as cartridge-boxes, bayonet-scabbards, haversacks, blanket-bags, canteens, musket-slings, swords, drums, bugles, flags, and spare parts for repairing muskets, &c	9,000 00		
For pupchase of ammunition	1,000 00		
For purchase and repair of instruments for band and purchase of music and musical accessories	500 00		
For purchase of tents and camp equipage	1,000 00		
		14,786 50	[illegible]
TRANSPORTATION AND RECRUITING.			
For transportation of troops and the expense of recruiting service	....	10,000 00	10,[illegible]
REPAIR OF BARRACKS.			
At Portsmouth, N. H., Boston, Mass., Brooklyn, N. Y., League Island, Pa., Annapolis, Md., headquarters and navy-yard, Washington, D. C., Gosport, Va., and Mare Island, Cal	15,000 00		
For introducing steam heating apparatus in marine barracks Portsmouth, N. H., as per estimate	1,750 00		
For erection of a building for marine barracks, navy-yard, Pensacola, Fla., to take the place of one destroyed on account of yellow fever (appropriation to be immediately available)	2,000 00		
For placing tin roofs on marine barracks and officers' quarters at Washington, D. C	1,200 00		
For rent of building used for manufacture of clothing, stowing supplies, and offices of assistant quartermaster, Philadelphia, Pa., and San Francisco, Cal	2,500 00		
For hire of quarters for 7 enlisted men employed as clerks and messengers in commandant's, adjutant and inspector's, paymaster, and quartermaster's offices, Washington, D. C., and assistant quartermaster's offices, Philadelphia, Pa., and San Francisco, Cal., at $21 each per month	1,764 00		
For hire of quarters for 3 enlisted men employed as above, at $10 each per month	360 00		
		24,574 00	10,[illegible]
NOTE.—Hire of quarters at $21 and $10 per month for the above enlisted men, authorized by the order of the Navy Department, dated 28th June, 1880, and 30th July, 1885.			

f appropriations required for the service of the Marine Corps, &c.—Continued.

l object of expenditure, and explanations	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation	Amount appropriated for the current fiscal year ending June 30, 1886.
FORAGE.			
n kind for 4 horses of the quartermaster's de- and the authorized number of officers' horses		5,400 00	5,400 00
CONTINGENCIES			
il at Marine Barracks, Portsmouth, N. H., Bos- Brooklyn, N. Y., League Island, Pa., assist- ermaster's office, Philadelphia, Pa., and San Cal., Annapolis, Md., headquarters and navy- hington, D. C.; Gosport, Va., Pensacola, Fla.; Island, Cal. (actual amount paid last year	5,460 48		
r bedding for enlisted men at the various posts ount paid last year)	1,093 53		
Marine Barracks, Boston, Mass., Brooklyn, N olis, Md., and Mare Island, Cal. (actual amount ear) ...	1,344 12		
e for Government houses	5,000 00		
for ferriage, toll, cartage, funeral expenses of tationery, telegraphing, rent of telephones, ap- i of deserters, per diem to enlisted men em constant labor, repairs of gas and water fixt- s and barrack furniture, mess utensils for en- , such as bowls, plates, spoons, knives, forks, ig boxes, wrapping paper, oil cloth, crash, rope, penters' tools, tools for police purposes, pur- repair of hose, repairs to public wagons, pur- repair of harness, repair of fire extinguishers, of hand grenades, purchase and repair of band- wheelbarrows, purchase and repair of cooking ages, &c., stoves where there are no grates, of ice, towels, and soap for offices, improving ounds, repair of pumps and wharves, laying l water-pipes, introducing gas, and for other	18,423 89	31,322 02	25,000 00
HIRE OF QUARTERS.			
quarters for officers serving with troops where no public quarters belonging to the Govern- where there are not sufficient quarters pos- the United States to accommodate them	....	4,500 00	4,500 00
		289,199 67	

ASTER'S DEPARTMENT, UNITED STATES MARINE CORPS,
Washington, D. C., September 28, 1885.

ly submitted.

H. B. LOWRY,
Quartermaster, Marine Corps.

ITERS UNITED STATES MARINE CORPS, COMMANDANT'S OFFICE,
September 28, 1885.

l approved.

C. G. McCAWLEY,
Colonel Commandant, United States Marine Corps.

Schedule of proposals received for supply of rations for the Marine Corps for the year 1885–'86, under advertisement from the Quartermaster's Office, dated May 12, 1885.

Names of contractors.	At Portsmouth, N. H.	At Charlestown, Mass.	At Brooklyn, N. Y.	At Philadelphia, Pa.	At Washington, D. C.	At Gosport, Va.	At Annapolis, Md.	At Pensacola, Fla.	At Mare Island, Cal.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
C. E. Filler				21					
T. J. Mooney								29	
John Kealy							14.85		
Thomas Callahan						*8.87½			
Hugh McHatton	17.97							†28.50	
Thomas J. Barbour						14.74			
Levi W. Norton	19.97								
Kelly & McInnis									24.75
J. F. Tobin									25.25
John Mullitt		†15.18							
James Brownlie									[illegible]
John C. Gilbert	†17.25	15.75	15.23						
J. C. Ergood & Co	18.67	15.40	15.60	16.79	15.10	15.77	16.69		
Frank Hume			17.39		15.59	16.15	17.67		27.[illegible]
Samuel Kimberly			15.89	15.79		†13.89	17.29		
Barbour & Hamilton			†15.00	†15.00	†14.00	15.00	15.00		

* For bread. † Accepted.

H. B. LOWRY,
Quartermaster, Marine Corps.

QUARTERMASTER'S OFFICE, U. S. MARINE CORPS,
Washington, June 17, 1885.

Schedule of proposals received for supplies for the Marine Corps under advertisement inviting proposals dated May 12, 1885.

Name.	Class.	Amount.
J. Rodel*	1	[illegible]
Horstmann Bros. & Co.*†	1, 2, 3	26,645 27
Pitkins & Thomas*	1	22,[illegible] 40
Thomas Kent*†	1	7,[illegible]
Rowland A. Robbins*†	1, 3	[illegible]
Charles W. Hayes*†	1, 3	7,121 33
James Tucker & Co.*†	1	2,[illegible]
Lyon Bros.*†	1	1,[illegible]
B. Y. Pippey & Co*†	1, 3	[illegible],074 [illegible]
Frank T. Wendell*	1	415 00
Charles F. Bush*†	1	3,[illegible] 75
C. W. Thorn & Co.*†	3	3,517 33
Robert C. Kretchmar*†	3	264 25
Richard Levicks, Son & Co.*†	1	[illegible] 00
T. A. Ashburner*†	1	27,723 85
Lewis Bros.*†	1	12,035 00
John Welsh*†	1	2,084 33
Thomas G. Hood*†	1, 2, 3	10,610 87
James Symington*	1	16,414 00
Raymond & Whitlock*†	1, 2	2,173 10
R. Warlitzer & Bro.*†	2	383 90
James C. Cooley*	1	12,085 00
S. H. Heilbrun*†	1	3,700 00
F. W. Maurer & Son*†	2	311 50
S. F. Pioneer Woolen Factory*	1	29,730 00

* Bid for part of class. † Awarded contract.

QUARTERMASTER'S OFFICE, U. S. MARINE CORPS,
Washington, D. C., June 22, 1885.

H. B. LOWRY,
Major and Quartermaster, Marine Corps.

lule of proposals received for supply of wood and coal to the Marine Corps under advertisement from Quartermaster's Office dated May 12, 1885.

ies of bidders.	Where to be delivered.	Wood. Oak, in stick.	Oak, sawed and split.	Pine, in stick.	Pine (kindling), sawed and split.	Coal. Red ash (egg).	Red ash (stove).	White ash (egg).	White ash (stove).	White ash (furnace).
		Per cord	*Per cord.*	*Per cord.*	*Per cord.*	*Per ton.*	*Per ton.*	*Per ton*	*Per ton.*	*Per ton.*
son Bros	Offices and officers' quarters, Washington and Georgetown, D. C., and within one mile of limits of said cities.	$5 50	$6 00	$4 50	$5 50	*$5 25	*$5 90	*$4 75	*$5 50	*$4 75
Killmon	do	6 22	7 20	5 32	6 00	5 54	6 30	5 40	5 50	5 40
Cross, jr	do	*4 69	*5 35	*4 13	*4 63	6 00	6 00	5 50	6 00	5 60
son Bros	Marine Barracks and navy-yard, Washington, D. C.	5 50	6 00	4 50	5 50	*5 25	*5 90	*4 75	5 50	4 75
illiams & Son	do							*4 45	*5 00	*4 45
Killmon	do	6 22		5 32				5 52		5 69
Cross, jr	do	*4 54	*5 00	*3 98	*4 38					
k K. Ward	Offices and officers' quarters and rendezvous, Philadelphia, Pa.	7 00	9 00	6 75	9 00		*5 24	*5 15		
e J. Convery	do	*6 00	*6 60	*6 00	*8 00		5 25	5 25		
i. M. Beall	Marine Barracks, Annapolis, Md.	4 48	5 98	3 48	5 98		5 66	*4 48	5 23	
Kealy	do	*3 85	*5 25	*3 45	*5 25		*5 40	4 03	*4 90	3 60
am G. Parker	Officers' quarters, Norfolk, Va.	*4 50	*6 00	*4 50				*5 50		
Do	Marine Barracks, Norfolk, Va	*4 00		*4 00				*5 50	*6 00	
am H. Sise	Portsmouth, N. H	7 90½	9 76	5 76	7 51			5 38		*5 75
W. Norton	Marine Barracks, Portsmouth, N. H.	7 25	9 25	5 50	7 00					
Walker & Co	do	*7 00	*9 00	*5 50	*7 00			*5 00		
el Littlefield	do	7 90	9 75	5 75	7 50					
Wellington &	Marine Barracks, Charlestown, Mass.	*7 75	10 25	*6 25	*8 75			4 95		
Campbell	do	7 95	*9 95	7 45	9 40			*4 90		
am D. Burns, jr	Marine Barracks, Brooklyn, N. Y.	*6 99	*7 49	*6 00	*9 00			4 49		4 49
el G. French	do	7 90	8 90	10 75	11 50			4 38		*4 38
k K. Ward	Marine Barracks, League Island, Pa.	8 00		7 50				*5 24		
e J. Convery	do	*7 50		*7 50				*4 95		
McHatton	Marine Barracks, Pensacola, Fla.	*4 75	*5 75	*3 50	*4 50					
am Wallace	Marine Barracks, Mare Island, Cal.	9 50	*10 25	9 50	11 25			14 00		
el G. French	do							19 00		
e McCudden	do							*11 77		
Bros	do	*9 00	*11 00	*9 00	*11 00			14 00		
Ebbetts	do							13 25		

* Accepted.

H. B. LOWRY,
Quartermaster, Marine Corps

ARTERMASTER'S OFFICE, UNITED STATES MARINE CORPS,
Washington, June 18, 1885.

A.—*Abstract of receipts and expenditures on account of the quartermaster's department, United States Marine Corps, for the year ending June 30, 1885, appropriation* 1884-'85.

	Appropriations.	Repayments from sale of fuel to officers.	Aggregate available.	Expenditures during fiscal year.	Balance of appropriation June 30, 1885.	Bills on file unpaid.
Contingencies	$25,000 00	....	$25,000 00	$24,564 55	$435 45	*[illegible]
Provisions	60,000 00	....	60,000 00	59,984 06	15 94	†[illegible]
Clothing	77,000 00	....	77,000 00	76,712 90	287 10	....
Fuel	18,000 00	$2,652 86	20,652 86	18,572 49	2,079 87	....
Military stores	9,786 50	....	9,786 50	8,154 53	1,631 97	....
Transportation and recruiting	10,000 00	....	10,000 00	8,552 32	1,447 68	‡1,[illegible]
Repair of barracks	12,250 00	....	12,250 00	12,021 52	228 48	§[illegible]
Forage	5,400 00	....	5,400 00	2,696 79	2,703 21	....
Total	217,436 50	2,652 86	220,089 36	211,259 16	8,829 70	11,1[illegible]

* Due Quartermaster's Department United States Army for freight charges, drayage in camp, [illegible]age for naval expedition to Aspinwall, and for repairs and expenses at Boston navy-yard.

† Due Bureau of Medicine and Surgery for rations stopped on account of naval hospitals. Due on reservation accounts to contractors for rations furnished.

‡ Due Bureau of Equipment and Recruiting, Navy Department, for transportation of relief crew to Iroquois. Due railroads for transportation of marines in connection with naval expedition to Panama.

§ Due for hire of quarters and repairs at Boston.

No. 11.—BUREAU OF EQUIPMENT AND RECRUITING.

NAVY DEPARTMENT,
BUREAU OF EQUIPMENT AND RECRUITING,
Washington, D. C., October 16, 1885.

: I have the honor to submit the following report of the opera-)f this Bureau during the fiscal year ending June 30, 1885, and to ɜ the estimates for the fiscal year ending June 30, 1887.

re was appropriated for the fiscal year ending June 30, 1885, the ing:

ɔent of vessels	$750,000
ortation and recruiting	25,000
gent	10,000
ıtablishment, Bureau of Equipment and Recruiting	9,000
;raining station, Coasters' Harbor Island	21,000
ruisers	78,600

·ing the year there were fitted for service at the various yards, ŗ or partially, and furnished with stores, 68 vessels, involving an diture of $64,217.03 for labor, and for material the sum of :33.91, making a total of $523,450.94 from the appropriation pment of vessels." This appropriation, being $146,000 less for the year than was asked for, has been exceeded about $32,000. The .sed consumption of coal in the North Atlantic and Pacific Squad- owing to the recent troubles on the Isthmus of Panama, and in .siatic Squadron by reason of the trouble between France and ., are largely responsible for the deficiency here reported.

: appropriation for transportation and recruiting was exceeded)2.95, but mainly on account of the difficulties occurring recently : Isthmus of Panama, and other unforeseen contingencies inci- :o the movement of ships in service abroad.

ıt for "civil establishment," being a specific appropriation for serv- ıs not been exceeded. The same may be said for "Coasters' Har- sland" at Newport. There will be a small unexpended balance to nto the Treasury.

:he estimates for the year 1887 the Bureau submits an estimate of 00 to make further necessary improvements at Coasters' Harbor l, and to maintain in good condition those already made at that

COAL.

e have been purchased for the use of vessels in service abroad ; home 45,235 tons of coal, costing, including expenses of delivery ndling, $379,619.43.

HEMP.

To meet the requirements of the service there were purchased du the year the following amounts of hemp:

Articles.	Quantity.	Valu
Manila hemp .... pounds..	180,360	
American hemp .... tons..	40[illegible]	
Russia hemp .... do...	76[illegible]	15,[illegible]
Total	....	49,[illegible]

The Bureau has been obliged to purchase abroad the steel-wire for the new cruisers on account of its inability to have wire of the sary tensile strength, elastic range, and ductility manufactured in United States. A contract was entered into during the year with a in Massachusetts, but after several failures had been made t was obliged to discontinue the contract. Rope manufactur au and delivered at New York navy-yard costs about 60 per cent. the lowest offer received for the wire alone in this country. The Gov- ernment patronage being so small and uncertain, it is not to be dered at that private firms are unwilling to undertake its manuf

ROPE-WALK.

The following amount of cordage, with the cost of labor and material, was manufactured during the fiscal year:

203,808 pounds manila	$40,
231,045 pounds hemp	52,
8,559 pounds iron wire	2,
1,205 pounds hide	1,
144 pounds copper	

When I assumed charge of the Bureau last year it was thought the cost of rope manufactured at the Boston yard was greater than supplied by private firms. Inquiry established the fact that voice prices of rope as fixed by the Bureau some years ago w higher than the present market rates, and as no change had been thorized since, instructions were issued to the commandant that all manufactured in future was to be invoiced to vessels at the actu c of its production. Complaints reached the Bureau that inferior r was being made for the service, and to be satisfied upon this p exhaustive trial was made at Watertown Arsenal with rope pur outside and that made at the navy-yard. It was believed with the best plants for rope-making in the United States, with no exp of insurance to be met, with no taxes to pay upon its value, and no profits to be declared, that the Bureau's loss of two hours pe would be more than offset by these expenses of the private manufa No comment is needed beyond the following tabulated results show strength and cost of each specimen:

port of mechanical tests made with the United States testing machine at Watertown Ar-ienal, Mass., of rope manufactured at the navy-yard, Boston, Mass., and of purchased rope of corresponding sizes.

Kind.	Size.	Cost per pound.	Strength.	Remarks.
	Inches.	*ts.*	*Pounds.*	
mp	4½	11	20,050	Made at navy-yard, Boston.
Do	4	11	15,400	Do.
Do	3½	11	10,300	Do.
Do	3	11	8,450	Do.
Do	2½	11	5,100	Do.
Do	2	11	3,980	Do.
lt rope	3½	15½	9,650	Do.
Do	3	15½	7,200	Do.
Do	2½	15½	5,180	Do.
nila	4½	13	16,800	Do.
Do	4	13	12,960	Do.
Do	3½	13	11,200	Do.
Do	3	13	9,650	Do.
Do	2½	13	7,460	Do.
Do	2	13	4,270	Do.
mp	4½	10½	13,500	Purchased.
Do	4	10½	11,400	Do.
Do	3½	10½	9,400	Do.
Do	3	10½	7,200	Do.
Do	2½	10½	5,150	Do.
Do	2	10½	2,640	Do.
lt rope	3½	14	8,000	Do.
Do	3	14	6,680	Do.
Do	2½	14	4,620	Do.
nila	4½	13	13,480	Do.
Do	4	13	11,980	Do.
Do	3½	13	10,750	Do.
Do	3	13	7,300	Do.
Do	2½	13	6,000	Do.
Do	2	13	3,500	Do.

)RGE, ANCHOR, SMITH AND CHAIN SHOPS, AND ROLLING-MILL AT WASHINGTON NAVY-YARD.

During the past fiscal year there has been manufactured in these iops the following:

ROLLING-MILL.

233 pounds chain-iron	$6,718 66
,974 pounds bar-iron	4,499 46
6,159 pounds plate-iron	4,054 93
Total cost	15,273 05

FORGE AND ANCHOR SHOP.

,795 pounds iron forging	$1,871 06
anchors, Government type, weighing from 500 to 6,500 pounds	4,324 81
anchors, Williams's pattern, weighing 5,000 to 6,500 pounds	5,618 43
Total cost	11,814 30

GALLEY SHOP.

galleys, No. 5	$3,081 88
galleys, No. 4	3,984 38
epairs to galleys of the Tennessee, Wyandotte, Trenton, Alliance, St. Louis, Pensacola, Saratoga, Brooklyn, Ajax, Tallapoosa, Iroquois, and Despatch, and for the Marine Corps and miscellaneous purposes, costing	2,376 79
Total cost	9,443 05

SMITH AND CHAIN SHOP.

540 fathoms 1¾-inch chain for Boston and Atlanta	
270 fathoms 2-inch chain for Chicago	
210 fathoms ⅞-inch chain for Boston and Atlanta	
210 fathoms 1-inch chain for Chicago and for general issue	
440 fathoms boat-chains	
9 sets chain appendages	
Mooring swivels, devil's claws	
30 boat anchors, from 32 to 98 pounds	
42 grapnels, from 8 to 100 pounds	
Other miscellaneous work	
Total cost	

In connection with the plant at this yard, I would state
material improvement has been added in years. Practically, tl
stands as it did 25 years ago. The cost of producing materia
kinds needed is greater from that cause than if bought in t
market, though there is much doubt whether the purchased
would be as good and reliable. It is believed that certain ver
sary improvements can be added to the rolling mill, to the forg
and to the machinery of this yard that will reduce the cost
plate, and other iron very materially, and which would almost
themselves during the first year in the saving that would be ef

The Bureau labors further under some disadvantage from t
ner of working incident to a system which appears wrong wh
pared with the methods employed in most private establishment
chain is made by expert workers, mostly Englishmen, who are
the weight of chain they produce. For example, in anchor-mak
tain parts are made by certain men. Some work palms an
others work shanks and stocks, and still others assemble and
together. This goes on from apprenticeship up. From the p
furnace to the completed anchor and chain all is done by laboi
in but one branch of the art. With us when busy, separate ga
required for the anchor and forge shops, the rolling-mill, th
and chain shops, and when work is slack, that our gangs may n
ter by discharge, we are obliged to keep all these men going on
time by giving all work enough to hold them. It often happen
that the forge and anchor men are obliged to run the heating f
and rolling-mill, and the chainmen to do general smith work, a
versa. But recently work was delayed on one chain-cable of
cruisers because one chain-maker was drawn for jury duty. The
difficulty, however, is the disadvantage of old-fashioned machin
the older expensive methods of reworking the old scrap-iro
which we depend almost entirely for our supply of iron for ma
uring purposes.

The Bureau would urge the necessity of keeping up a tho
equipped rolling-mill, chain and anchor shop at the Washingt
and above all things to possess a first class testing machine to p
work and to make experiments and researches with a view to es
ing standard tests for chains and anchors intended for the me
marine. A plant, so improved, if it was only occasionally use
be held as a check against possible combinations of private dea

The Bureau would suggest the great importance of some l
looking to the proving of anchors and chains intended for our v
war and for those of the mercantile marine. The safety of prope
life afloat are often as dependent upon strong chains and good
as upon strong engines and good boilers. Compulsory i

these articles will be the means of saving much to the Govern-
well as to the underwriters. The last resort of vessels is fre-
her "ground-tackle;" it should therefore be of the best.
English Government requires all cables and anchors to be tested
ixed standard. All defective and inferior work is shipped abroad
l cheap. Much of it is said to find its way to our country to the
nt of our workers. The British Lloyds refuse first-class ratings
ls with untested chains. Excepting the Navy, most of the chain
r the Light-House Board, the Engineer Department, U. S. A.,
st Survey, and the Fish Commission, is made by the lowest-bid-
ring, and is required to undergo variable tests, mostly, however,
rdance with some foreign requirement. A law in this country
ig standard tests would protect owners and underwriters, and
be in the interest of every manufacturer against the inferior
purchased abroad.
Bureau being the only department of the Government engaged
ufacturing chains and anchors, it is eminently proper that the
ions and tests here indicated be placed under its control and
n. As much experimental work on the tensile strength, ductility,
ty, &c., of American iron and steel has been done under its direc-
ere has been established for its own guidance the only stand-
ed on these results. They have been found to differ very ma-
from the usual rules used in England. No expense will attend
sage of such a law beyond the travel of the inspecting officer.
pense to the owners of vessels or to underwriters will be nothing
postage.

TRAINING APPRENTICES FOR THE NAVY.

e are established at the larger sea-port towns receiving ships
apprentices may be enlisted for the Navy. During the year the
r of applicants reached 3,754; the number rejected for various
2,601; leaving the number accepted 1,153.
is number there were 394 who failed to report after examination,
the number actually received into the service was 759.
following affords an actual exhibit of the number of apprentices
service on the last of the fiscal year: Number of apprentices
d stationary and cruising training-ships, 749; number on board
g vessels of the general service, 528; total number in service,

e on board the cruising vessels of the service were distributed as
:

lantic Station	126
lantic Station	57
tation	77
n Station	81
tation	187
tal	528

system at present in force after enlistment embraces, for a period
it six months, primary instruction in the ordinary branches of
a education, and the preliminary instruction in knotting, splic-
ating, signals, &c., and infantry exercises on board the New
hire. Those qualified at the expiration of this period are trans-
to the cruising training-ships, and a further period of similar
tion is continued at sea. After their return from this cruise,

lasting several months, all found qualified are transferred to the c of the general service, where their usefulness is found to be ι marked. The cruising training-ships Portsmouth, Jamestown, and atoga have been kept at sea as much as practicable. In the early of the year a cruise of several months' duration was made to the W ward Islands with very gratifying results. In May they sailed on a European cruise of several months' length, but had not returned at end of the fiscal year, though excellent results have been report abroad.

TRAINING-SHIPS.

The cruising training-ships Portsmouth, Jamestown, and Saratoga are in such condition as to require constant repairs. The time is at hand when they will be unseaworthy. When built, and for years afterward, these were most excellent vessels for training poses, but as steam has now become the principal motive power as war vessels are yearly growing more into machines with sub sail power, it is believed that if we are to keep abreast of, and ou prentices are to be made familiar with, the improvements and req ments of the modern war ship in which they are to serve, with complicated machinery for offensive and defensive purposes, their liminary instruction should begin in a type of vessel more nearly the modern war ship. In this view the cruising training-ships sl be of the most modern type and construction. All that is now them on these old vessels could be as well taught on board the ne types, together with very much more that they can only learn now their transfer. If the real usefulness of their lives is to be begun after preliminary training ends in the training squadron, then we are wa time in these old antiquated types of ships that have had no use in the tles of the last twenty-five years, but which bear about the same tion to the modern war ship that the ordinary "tallow dip" does to electric light.

The Bureau would therefore urgently recommend for your c ation the construction of two composite vessels engined with aux steam power and lifting screws, armed with modern guns and n with the newest torpedo attachments. The Bureau is of opinion this would be a wise and economic measure, and would obviate stant extensive and costly repairs of these old and almost ou training-ships.

SAIL LOFTS.

In the sail lofts at the various yards there have been expended and material in making sails, awnings, hammocks, clothes the following:

For material	
For labor	
Total	

PENSIONS.

ions under the sixth section of the act of March 2, 1867, sec-
'56 and 4757, Revised Statutes of the United States.

Nature of claim.	Claims filed from March 2, 1867, to June 30, 1884.	Claims allowed and certified to Commissioner of Pensions from March 2, 1867, to June 30, 1884.	Claims disallowed from March 2, 1867, to June 30, 1884.	Claims pending June 30, 1884.
s of twenty years	502	361	115	26
s of ten years	486	297	144	45
al of pension	118	110	5	3
se of pension	19	13	6	0
	1,125	781	270	74

Nature of claim.	Claims filed during fiscal year ending June 30, 1885.	Claims allowed and certified to Commissioner of Pensions during year ending June 30 1885.	Claims disallowed during year ending June 30, 1885.	Claims pending June 30, 1885.
of twenty years	35	30	10	21
s of ten years	20	29	22	23
al of pension	5	7	1	0
se of pension	5	2	3	0
s of pension	1	0	0	1
of claim	1	0	1	0
	76	68	37	45

RECAPITULATION

d from March 2, 1867, to June 30, 1885, inclusive		1,201
wed during said period	849	
llowed during said period	307	
ding June 30, 1885	45	
		1,201

ENLISTED MEN.

e 30th of June there were 8,203 men and apprentices. The
number has not exceeded the legal quota.

wed	7,500
ted during fiscal year at rendezvous	1,762
ted on board vessels	2,953
s during year	3,732
s during year	941
	43
loyed in Fish Commission	134
loyed at Naval Academy (summer)	300
loyed at Naval Academy (winter)	112
loyed in Coast Survey	275

Bureau would again reiterate the recommendation of previous
that the force employed at the Naval Academy, in the Fish

Commission, and Coast Survey be allowed independently of the 7 men intended for the general service. The increasing requireme these services draw largely upon the quota established by law for Navy, and is often the occasion of much embarrassment to the ment of our war ships. The force for these services should be to 500 men, and should be known as "auxiliaries for special ser otherwise when these men are supplied as required the force rem is not sufficient to properly man the regular cruisers.

The cost of maintaining the Fish Commission from pay of Navy for the fiscal year was $76,252.

The cost of maintaining the Coast Survey from pay of Navy for the fiscal year was $256,176.

It is true that most of the work of the Coast Survey and of the Commission is done with the aid of the officers and enlisted men o Navy, but the Bureau does not think that it is understood by the p that these two services claim so much of the available force of the Navy as 409 men to perform their duties and draw so largely upon its appropriations to defray the expense of these two establishments.

The Bureau would renew its recommendation of last year for le tion to allow honorably discharged men to elect a home on board of the receiving ships during the three months granted by law as limit of time within which to re-enlist after discharge, the men so c ing a home to be entitled to one ration per day for their keeping an be amenable to such regulations as the Bureau may establish while residing. By this arrangement these men would be able to escape discomfort now experienced in our larger cities, where many are driven by necessity after their discharge into miserable and uncleanly b ing places. Much benefit would accrue to the service in the impro character of its personnel if legislation could be secured to enable honorably discharged men to take advantage of these vessels as during the three months allowed them to re-enlist after discharge.

The Bureau has anticipated to some extent the improvement taking place in the various implements for offense and defense in to be used on board of our new war vessels by organizing a class of n men, taken from the general service, one-half of which are now being trained in the use of all the electrical apparatus and fittings at the pedo station at Newport; the other half are being trained in the t tools, lathes, and other implements of the ordnance shops at the navy-yard, Washington. When each class shall have completed their of training at Newport or at Washington they are to change sta and ultimately they are to be transferred to the general service, v they can act as instructors to the crews, and their places are to be plied by others drawn from the general service for similar instru until a sufficiently large body of trained men shall have been se

I would suggest the importance of amending section 2166 of vised Statutes, referring to aliens in the Army becoming citizens to include the Navy. Also that sections 4756 and 4757, relating to sions, be amended so as to include men who have served as app petty officers, some of this worthy class of necessary men being excluded from pension benefits by not having been enlisted.

The Bureau would again submit its recommendation of last y relation to the matter of outfit for enlisted men of the Navy. It is lieved if an outfit of clothing could be given as a gratuity to on enlistment that much of the desertion now occurring wou vented. At the present time the clothing outfit of a recruit co s three months of his pay, which must be assumed as a debt to

ınt. In many cases the clothes are worn out before they can be 'or by service, and while so indebted the recruit enjoys no privi- of liberty nor money for personal use. As a matter of course this em is looked upon as discouraging by the sailor, if not oppressive. tions follow, with theft of outfit, as a result of the present system. is believed that if the enlisted men of the Navy were placed upon a what similar footing with those of the Army and Marine Corps in matter of a clothing outfit on enlistment there would be less fre- ent desertion and much more contentment with the service.

The Bureau has also in view the improvement in all mess conditions the men by which better means of preparing, cooking, and serving ir rations can be effected, and hopes to succeed in establishing a ter system of cooking by training a few men annually in the art of bining to the best advantage the various articles of the Navy ion.

At present there are no libraries for the crews of our war vessels and appropriation for this purpose, but as their better training would re- t with opportunities to improve their minds during some of the idle urs when off watch at sea or in port, I would respectfully urge a ll appropriation to begin this important work. The Bureau would st $10,000.

The Bureau would urgently recommend the importance of some leg- ion looking to the retirement of enlisted men of the Navy after thirty of service, as in the Army and Marine Corps at present. Under ing laws the pension allowance of seamen is but a pittance to de- d upon when no longer able to serve, and in cases where the disa- ty of age prevents the recipient from adding something to this small wance there is some distress. The Bureau believes that the exposure, rations, and hardships of the seaman incident to his life at sea or in healthful ports abroad entitle him to the same consideration as the rine who serves on board ship with him, and it would be a great re- to many of our worn-out old veterans if they could be assured of care from the Government they have upheld through storm and during at least two of its wars. In their behalf the Bureau would ercede for an amendment to the statute passed February 14, 1885, to lude the Navy.

One other matter of vital importance to the efficiency of the service to the welfare of the men is that they should be permitted by law system of savings bank similar to that enjoyed by their Army as- tes. This law for the Army was enacted in 1872, and has been mended in the highest terms as a means by which desertions have largely checked and the *morale* of the Army much increased. By on 1305, Revised Statutes, any enlisted man of the Army is per- ted to deposit his savings in sums not less than $5 with any Army master. The money so deposited is to be accounted for in the same nner as other public funds, and passes to the credit of the appropri- n for the pay of the Army. These savings are not subject to forfeit- by sentence of courts-martial, but are forfeited by desertion, and paid upon the final discharge of the soldier, or to his heirs if de- d. The Government is made liable by law for the amounts de- ed. By section 1306 the rate of 4 per cent. interest per annum on deposits has been established for any sum not less than $50 so ed for a period of six months or longer, to be paid the soldier discharged.

service of sailors being always without the United States, there opportunities to invest their earnings, as might sometimes occur

with their companion in arms of the Army, and unless some care of sort be thrown around them by their Government most of their savings are squandered away from home or wrung from them after their return by unscrupulous boarding-house keepers.

I would earnestly recommend this matter to your attention with a view to securing such legislation on this subject as may place the sailor on an equal footing with his Army comrade.

In recruiting for the Navy it has been customary for years to read over to the recruit the shipping articles before they are signed, in order that he may thoroughly understand the responsibilities of the service he is about to undertake, but there is no authority of law for a commissioned officer of the Navy to administer the oath of allegiance to recruits, as prescribed for the Army in article 2, section 1342, Revised Statutes; and as there are no notaries public appointed on board receiving-ships or at naval rendezvous, the binding particulars of an oath cannot be lawfully prescribed, as everywhere else in the Government military service, as a necessary preliminary to appointment to place.

If the statute quoted could be made to include the Navy, oaths could be lawfully administered by commissioned officers of the Navy and the matter of enlistment thus given more solemnity and binding force than at present.

The Bureau has the honor to transmit herewith an itemed estimate of the additions to the plant at the Washington yard, showing in detail what is needed to modernize it so that all articles manufactured in future may be produced at much lower cost than is now possible, and would earnestly request their recommendation.

Very respectfully, your obedient servant,

W. S. SCHLEY,
Chief of Bureau.

Hon. WILLIAM C. WHITNEY,
Secretary of the Navy, Washington, D. C.

ADDENDA TO REPORT.

Statement showing amounts appropriated, amounts expended, balances on hand June 30, 1885, and estimates of the probable demands which may remain on each appropriation.

Appropriations.	Amount appropriated.	Amount expended.	Balance on hand June 30 1885.	Probable demands on appropriation.
Equipment of vessels	$750,000	$682,122 21	$67,877 79	$103,[illegible]
Transportation and recruiting	25,000	24,921 44	78 56	27,[illegible]
Civil establishment	9,000	8,563 27	436 73	....
Contingent, Bureau of Equipment and Recruiting	10,000	9,983 00	17 00	3,[illegible]
Steel cruisers	78,600	60,318 89	18,281 00	....
Training station	21,000	18,048 07	2,951 93	2,[illegible]

Schedule of bids for water supply at Coasters' Harbor Island, under advertisement dated April 28, 1885.

Philip T. Conroy: $1.750 for artesian wells; for piping, $1.50 per foot.
Manhattan Artesian Well Company: $7,000, or $5 per foot if under 1,000 feet.
Jesse Button: $10 per foot up to 1,000 feet; reservoir, $500.
Delbert L. Barker: *$1,875 for five wells to furnish 30,000 gallons daily; reservoir, *$502.16; overflow pipe, *$473.04; suction pipe and trenching, $2,143.80; for supply main, $427.50.

*Accepted.

ents showing amounts expended during fiscal year ending June 30, 1885, for wages of anics and laborers and for the purchase of materials for repairing or equipping ves- of the Navy, showing cost of stores received, expended, and on hand June 30, 1885.

ıded for wages of mechanics and laborers	$244,282 00
ıded for the purchase of material, &c	300,014 54
ıted value of stores on hand June 30, 1884	1,727,937 59
·ed during fiscal year	699,957 60
,ded during fiscal year	892,627 10
ated value of stores on hand June 30, 1885	1,595,268 09

Estimate to modernize rolling-mill, forge, and anchor shops.

·sting machine (Emery)	$30,000
›tary squeezer, for puddle balls or 150-pound scrap piles	4,050
eam-engine, suitable to drive same, cylinder 12 by 24 inches	1,950
eating furnace complete	710
air Gothic puddle rolls for old mill; air rolls for making 5-inch puddle bars, with guides and rest bars ›oth pairs	1,452
?-inch three high guide rolling-mill complete, chilled rolls and all fit- s	7,275
eam-engine, suitable to drive the same, cylinder 18 by 22 inches and ı extra heavy fly-wheel	4,000
ıst-iron straightening plate, 2 feet by 30 inches	289
·ails for hot bed	168
ıt and erection expenses on the above	1,000
ib cranes	2,500
ıir rotary shears, for thin plate	500
new boilers set in masonry	5,000
	58,894

!e of bids for improvements at Naval Training Station, Coasters' Harbor Island, under advertisement dated August 25, 1884.

ıes of bidders.	Water supply.	Steam-heating apparatus.	Two 60-horse power boilers.	Six hundred feet sewer pipe.	Electric lighting.	Remarks.
;ngland Weston lc Light Company.					†$7,480	For underground wires.
·o					7,180	For overhead wires.
,bcock & Wilcox ,any.			*$3,755			
& Butler				$295		
rth Manufactur- ompany.		*$3,287				
Company for Iso- Lighting.					*8,150	For underground wires.
·o					7,850	For overhead wires.
?. Conroy & Co.	*3,150	†2,100				

*Accepted. †Incomplete.

Estimates of appropriations required for the service of the fiscal year ending June 30, 188[illegible] by the Bureau of Equipment and Recruiting, Navy Department.

Detailed objects of expenditure, and explanations.	Estimated amount which will be required for each detailed object of expenditure.	Amount appropriated for the current fiscal year, ending June 30, 188[illegible]
EQUIPMENT OF VESSELS.		
For coal for steamers' and ships' use, including expenses of transportation, storage, and handling, hemp, wire, hides, and other materials for the manufacture of rope and cordage; iron for the manufacture of anchors, cables, galleys, and chains; canvas for the manufacture of sails, awnings, bags, and hammocks, heating apparatus for receiving ships, and for the purchase of all other articles of equipment at home and abroad, and for the payment of labor in equipping vessels and manufacture of equipment articles in the several navy yards (appropriated; 23 Rev. Stat., pp. 428-733, secs. 3709, 3747, 1)	$860,000 00	
TRANSPORTATION AND RECRUITING.		
For expenses of recruiting for the naval service, rent of rendezvous, and expenses of maintaining the same, advertising for men and boys, and all other expenses attending the recruiting for the naval service, and for the transportation of enlisted men and boys, at home and abroad (appropriated, 23 Rev. Stat., pp. 428-721, secs. 3666, 1)	30,000 00	
CONTINGENT.		
For extra expenses of training ships, freight and transportation of equipment stores, printing, advertising, telegraphing, books and models, postage, ferriage, ice, apprehension of deserters and stragglers, continuous-service certificates, good-conduct badges, and libraries for enlisted men, school books for training ships, medals for boys, and emergencies arising under cognizance of the Bureau of Equipment and Recruiting, unforeseen and impossible to classify (appropriated, Rev. Stat., p. 721, sec. 3666; 23 Stat., p. 428, sec. 1)	20,000 00	1[illegible]
NOTE.—The amount appropriated under head of Contingent E. & R. for the past fiscal year has been found entirely inadequate to meet the requirements of the service, and a deficiency appropriation will be necessary to settle outstanding obligations incurred abroad. In view of the increased expenditures on account of advertising, and the additional item of "libraries for seamen" embraced in the estimate for the next fiscal year, it has been increased $5,000 over the amount appropriated for 1886.		
NAVAL TRAINING STATION, COASTERS' HARBOR ISLAND.		
For extending wharf and dredging, repairs to main causeway, sea wall, roads, buildings, and grounds at the naval training station, and the necessary labor and implements required for the proper preservation of the same (appropriated; 23 Stat., p. 497, sec. 1)	30,000 00	25,0[illegible]
CIVIL ESTABLISHMENT.		
Navy-yard, Kittery, Me.:		
One clerk	1,200 00	
One writer	1,000 00	
Navy-yard, Charlestown, Mass.		
One superintendent of rope-walk	1,800 00	
One clerk	1,400 00	
One clerk	1,200 00	
One writer	1,000 00	
Navy-yard, Brooklyn, N. Y.		
One clerk	1,400 00	
One clerk	1,200 00	
Navy-yard, League Island, Pa.:		
One clerk (appropriated, R. S., 23, p. 428, sec. 1)	1,200 00	
Navy-yard, Washington, D. C.:		
One clerk	1,400 00	
One clerk	1,200 00	
One writer	1,000 00	
Navy-yard, Norfolk, Va.:		
One clerk	1,200 00	
One writer	1,000 00	
Navy-yard, Pensacola, Fla.:		
One writer	1,000 00	

mates of appropriations required for the service of the fiscal year, &c.—Continued.

Detailed object of expenditure, and explanations.	Estimated amount which will be required for each detailed object of expenditure.	Amount appropriated for the current fiscal year ending June 30, 1886.
CIVIL ESTABLISHMENT—Continued.		
yard, Mare Island, Cal.:		
ne clerk	$1,200 00	
ne writer	1,000 00	
		$9,000 00
	20,400 00	
E.—The appropriation of $9,000 for the past and current fiscal under head of "Civil Establishment E. & R.," has been sufficient r the payment of one clerk at each of the several navy-yards. As rce is found to be entirely inadequate to the proper performance duties, an increased itemed estimate is submitted, which is into cover the total force employed in a clerical capacity at each of veral navy-yards. The amount expended from appropriations of ureau for objects enumerated in section 3, act of January 30, 1885, 13,989.75.		
SALARIES.		
ief clerk (March 3, 1885, Rev Stat., p. 70, sec 416; 23 Stat., p. 414, sec. 1)	$1,800 00	
erk of class four (March 3, 1885, Rev. Stat., p. 27, sec. 167; 23 Stat., 4, sec 1)	1,800 00	
erk of class three (March 3, 1885)	1,600 00	
lerks of class two (March 3, 1885)	2,800 00	
clerks of class one (March 3, 1885)	3,600 00	
opyists (March 3, 1885)	1,800 00	
sistant messenger (March 3, 1885)	720 00	
borer (March 3, 1885)	660 00	
	14,780 00	14,780 00
EQUIPMENT PLANT, NAVY-YARD, WASHINGTON, D. C.		
sting-machine. Emery (submitted)	$30,000 00	
otary squeezer for puddle-balls or 150 pound scrap piles (submitted)	4,050 00	
eam engine suitable to drive same, cylinder 12 by 24 inches	1,950 00	
ating-furnace complete (submitted)	710 00	
air Gothic puddle-rolls for old mill; one pair rolls for making 5-inch ile bars, with guides and rest bars for both pairs (submitted)	1,452 00	
-inch three high guide rolling-mill complete, chilled rolls and all fits (submitted)	7,275 00	
eam engine suitable to drive the same, cylinder 18 by 22 inches, and extra heavy fly-wheel (submitted)	4,000 00	
ast iron straightening plate, 2 feet by 30 inches (submitted)	289 00	
ails for hot bed (submitted)	168 00	
t and erection expenses on the above (submitted)	1,000 00	
ib-cranes (submitted)	2,500 00	
air rotary shears for thin plate (submitted)	500 00	
new boilers set in masonry (submitted)	5,000 00	
	58,894 00	
INCREASE OF THE NAVY.		
omplete equipment outfit of new steel vessels, including two come bark-rigged sailing vessels, with auxiliary steam-power, for ing squadron (submitted)	725,000 00	

No. 12.—BUREAU OF ORDNANCE.

BUREAU OF ORDNANCE, NAVY DEPARTMENT,
Washington City, October 15, 1885.

SIR: I have the honor to submit the annual report of this Bureau, and also to transmit estimates for the fiscal year ending June 30, 1887.

(1)	Fuel, tools, material, and labor; batteries of the new types for six ships now in service: towards the general armament of the Navy with modern secondary batteries and small-arms; proof of naval guns and their appendages; modern armament of two practice-ships for the training-squadron, and establishment of a proving and ranging ground	$1,112,750 00
(2)	General repairs to ordnance buildings, magazines, and appendages	15,000 00
(3)	Freight and miscellaneous expenses	5,000 00
(4)	Civil establishment at navy-yards	23,822 75
(5)	General expenses of the torpedo-station; purchase of a torpedo-boat, and of auto-mobile torpedoes	250,500 00
(6)	To supply the ordnance outfit of the monitor Miantonomoh	207,000 00
(7)	To supply the ordnance outfits of the monitors Puritan, Terror, Amphitrite, and Monadnock	866,000 00
(8)	For one 12-inch B. L. rifle	60,000 00
(9)	For the armament of the four new vessels authorized by act approved March 3, 1885	878,770 00
(10)	For the purchase of improved and more powerful machinery for the manufacture of cannon	50,000 00
		3,468,842 75

CANNON.

TYPE GUNS.

Congress not having appropriated for the construction of any more type guns, no new ones have been commenced this year. The number of rounds fired by the first 6-inch gun, however, has been carried to 275. Its behavior has continued to maintain the merits of the design. A 5-inch gun has been completed and had a preliminary trial; it has thus far proved satisfactory.

The construction of the first 8-inch gun has progressed considerably since last report. The rings have arrived from England and are being put on as rapidly as possible.

The introduction of the slow-burning brown (or cocoa) powder has rendered some additional hooping necessary on the chase of this gun, and the forgings for these hoops are being made as rapidly as possible, and when machined will be shrunk on. When this is done the gun will be completed at once and its ballistics determined.

The tubes and jackets of the first 10-inch guns are assembled, and most of the rings have very recently arrived from Europe. Certain chase and muzzle rings will be made in this country as soon as practicable.

The use of the new slow-burning powder has resulted in carrying the

highest pressures in the bores of guns much further along the chase than was the case when black powder only was used.

This fact calls for additional strength forward of the trunnions, and accordingly the 8-inch and 10-inch guns are receiving additional rings on the chase (as mentioned).

Forgings for the 10½-inch gun have been very recently received from Sir Joseph Whitworth & Co. Manufacture has not commenced, and no funds are now available for the purpose.

A preliminary computation and a drawing of the 16-inch gun (110 tons) have been prepared; and the latter will be found in Appendix.

The drawings and calculations of resistance for the strengthening of the 8-inch gun and for the construction of the 16-inch gun were made by Lieut. A. R. Couden, U. S. N., who has also done much other valuable work.

The winding of wire on the first 6-inch wire-wound gun has been completed. It was laid on with varying tension according to the formulas deduced by Ensign Philip R. Alger, U. S. N. The compression of the bore was very uniform, and in accordance with the anticipations of the Bureau. It is given in the Appendix.

The use of spring-firing attachments with the type guns has continued, and a good deal of experience has been gained with these rather troublesome apparatus. The one that promises best of those thus far tried is in a satisfactory state. A new design is represented in the Appendix. This promises well, is light and simple, and will be tried if occasion offers.

POWDER.

Within the past year very notable progress has been made in the development of powder for great guns.

After the purchase and arrival of the German brown (or cocoa) powder referred to in last report, the Bureau began experiments at the naval ordnance proving ground at Annapolis, with a view to the production of a domestic powder that would repeat the excellent results of the German sample. At first only moderate success was attained, but finally, by repeated trials at the proving ground, and by much practice there with samples made by the Messrs. Du Pont & Co., a specification was settled upon that is thus far uniform in its action and gives in the 8-inch gun most gratifying velocities for the pressures developed.

The characteristics of the grain as regards its rate of burning are under complete control in manufacture, and the photographs in the Appendix, page 237 (showing an unburned grain and two which were blown out partly consumed), illustrate the progressive nature of the combustion, there being an increasing surface outside of the prism as well as through the central perforation.

A series of trials are in progress with the German and domestic powder for the purpose of developing the comparative hygrometric qualities of the two and the rate of burning as affected by temperature. Thus far no unfavorable indications have been obtained with respect to the domestic grain.

The Bureau has ordered another sample lot, which will be delivered shortly, and it is to be hoped it will prove equal to that last fired. To successfully manufacture brown powder in our country is a point of the greatest interest to us, and its importance cannot be overrated. To be independent of foreign manufacturers for the supply of the only known powder that is really suitable for use in high-power guns as now

constructed, is a matter that should concern every American. Commander W. M. Folger, U. S. N., has had immediate direction of affairs relating to the development of this powder, and his course throughout is highly appreciated by the Bureau.

The highest results obtained with this powder in the six-inch gun are as follows:

Charge.	Muzzle velocity.	Pressure.
Pounds.		
52	2,036	15.8
51	2,021	15
50	2,011	14.8

The limited firing had with the five-inch gun has been equally favorable.

It is probable that the Bureau will ask the Messrs. Dupont to alter the size of the prism to one that will accommodate itself to a greater number of calibers of our guns.

Considerable work has been done in connection with the development of suitable powder for the Hotchkiss machine cannon, lately adopted in this and other countries. Specifications of black powder have been established for each caliber, which give results generally superior to those obtained abroad, and will enable us to make large quantities of powder for these very important guns at any time it may be required. An account of the trials (which took place at the naval ordnance proving ground) and the results obtained will be found in the Appendix, page 237.

The trials of small-arm powder commenced last year at the naval ordnance proving ground (detailed in the last report) have been prosecuted with the result of grading the powders used by private and other establishments and showing the relative values of different ammunition for naval purposes.

PROJECTILES.

Some slightly-improved forms of common shell have been introduced, with a view to more resistance in the gun and against targets.

Instructive practice has been had against an 8-inch compound armor plate, from the 6-inch B. L. high-power rifle, using tempered projectiles, some of carbon and some of Chrome steel. The results (which are detailed in the Appendix, pages 229 and 231) are instructive, showing the resisting power of the plate and the progress that has been made in the adaptation of the projectile to its purpose.

The great energy carried to the target by the modern projectile calls for the utmost resisting power on the part of the latter, and it is reasonable to suppose that considerable time will be required to develop the best temper and other conditions of metal to do effective work on hard-faced plates. It is not too much to say that the last six-inch shot tried by us have done fully as well as those thus far tried abroad, and it is thought that we shall speedily surpass the results now obtained.

The constant advance made in the resisting power of armor calls for continued effort to develop the power of the projectile, and this is a species of work which is not likely to be concluded until the resisting qualities of armor have reached their maximum, and been overcome by the projectile.

GUN-COTTON ARMOR-PIERCING SHELLS.

ne very important experiments were undertaken by the Bureau at aval ordnance proving ground for the purpose of investigating uestion of controlling the action of gun-cotton when used as the ing charge of armor-piercing shells. These trials were mostly ed out with the six-pounder rapid-fire Hotchkiss gun against tar- of from 3 inches to 6 inches thick. They were quite successful, howed that the gun-cotton bursting charge could be so controlled its tendency to detonation by shock of departure from the gun f arrival against armor could be lessened sufficiently to render ration by projectiles carrying such a charge quite practicable.

"delayed-action" fuze has been devised, which accomplished ex- on of the wet charge after the passage of the projectile through the , and is simple in structure and action.

is delayed-action fuze was used very successfully to explode sev- 3" muzzle-loading rifle shells (charged with gun cotton) in the ex- on chamber, and the results were very favorable, the number of nents obtained and character of fracture showing that complete ation was obtained.

e scheme of experiments from which the foregoing results were ned is very creditable to Commander Folger, by whom it was pro- l and conducted, and the results are extremely valuable, as they lish the principles upon which gun cotton can be safely used in shells, and thus facilitate greatly the preparations for practice ist armor with heavier shells.

GAS CHECKS.

rther and very extensive trials have been had with the De Bange heck. Much of this practice has occurred in connection with the ' of the 6-inch guns for the new steel cruisers. The check was l to be more satisfactory than any other thus far brought forward; ccasionally it would stick badly in the chamber without apparent . The Bureau early replaced the tin and brass rings (used by the guished inventor) with steel, finding improved action; but still ehavior of the check called for improvement. Commander Folger ately introduced an anti-friction washer, that he substituted for the g which has heretofore been used on the mushroom stem. This apparatus appears to be quite successful, and enables the operator en the breech of the gun with ease after discharges which produce mber pressure of over 15 tons per square inch.

is is a very important step, and will be found figured in the Ap- ix, page 241.

GUN CARRIAGES.

ie alterations have lately been made in the design of the ordinary ty-return broadside carriage.

ey result in improved action, and the carriage as now arranged is n in the Appendix.

e 8-inch barbette carriages of the Boston and Atlanta have been ed to work by power, as shown in the Appendix.

design for 8-inch and 10-inch pivot carriages is shown in the ix. It affords a better support against and distribution of l thrust than those now in vogue, and is strong and compact.

Preliminary designs of central-pivot carriages for the guns of the four cruisers authorized by the last Congress are figured in Appendix.

In originally designing all our gun carriages it was intended to use unhammered cast steel as much as possible, casting each part in a single piece with all the necessary projections and attachments in place. Unfortunately it has been found that the steel cast in these somewhat complicated forms does not resist well the fire of light projectiles, being more or less cracked and broken by shot from the Hotchkiss and other guns.

For this reason the Bureau has been obliged in a measure to go back to wrought iron. It is believed, however, that the ductile qualities of unhammered steel (when cast into elaborate forms) may shortly be so improved as to render its use for gun carriages, &c., prudent.

Several new designs of mounts (or carriages) for machine cannon have been completed and are shown in the Appendix.

Some are for the decks of ships and some are for the tops.

All the new carriage designs are largely due to Lieut. Charles A. Bradbury, U. S. N.

HOTCHKISS GUNS.

Since last report the 47mm. and 57mm. rapid-fire Hotchkiss guns therein mentioned have been received, and used at the naval ordnance proving ground.

As previously stated, suitable black powders have been determined upon for each caliber.

As it is very desirable that manufacturers in our own country should be able to produce the Hotchkiss ammunition (of which immense quantities would be used in war on account of the rapid rate of fire of these guns), efforts have been persistently made by the Bureau to produce a quality of steel shells here that would be superior to those purchased abroad. This has been effected, and the Bureau has produced projectiles that have been fired several times through the maximum thickness of steel (about three inches) without practical deformation.

There is a system of "rolling" steel objects which has lately come forward, and appears to promise the comparatively cheap production of projectiles for machine and other cannon. Of course cast-iron shell do not offer any particular difficulty and are made at the Washington navy-yard when desired.

The Winchester Repeating Arms Company is engaged in some experiments on the drawing of solid cartridge-cases for Hotchkiss ammunition, and it is hoped that their efforts will be successful.

At the ordnance department of the Washington navy-yard work on the armaments of the new steel cruisers has been pushed as rapidly as possible, and also all of the matters incident to general work of the Navy. A small estimate for increase of machinery has been submitted this year. In case this Department were placed on a suitable footing, however, several heavy traveling and stationary cranes would be required, as well as a good deal of modern machinery. Much of the machinery we are now using is the property of the Bureau of Steam Engineering and the Bureau of Construction and Repair.

SEAMEN GUNNEI

The instruction of seamen gr
the Washington navy-yard

service men" has been added to them, at the request of the Bureau of Equipment and Recruiting, and a course of instruction for both has been arranged (and entered upon by the men) both there and at the torpedo station, Newport, R. I.

The time covered by instruction and practice at each place is about six months, and the resulting benefit to the service will of course be very great. It is proposed to increase the size of classes as much as practicable, and to supplement the instruction by the issue of "catechisms" on ordnance subjects for the use of the men on shipboard.

ARMAMENT OF THE NEW VESSELS.

Since last report five 6-inch and two 5-inch breech-loading high-power steel guns have been completed at the ordnance department of the Washington navy-yard, and are now at the naval ordnance proving ground, where they have fired ten proof rounds each. They perform satisfactorily, and several will be mounted on the Atlanta when she is ready to receive them.

Nineteen sets of steel forgings for 6-inch B. L. R., made by the Midvale Steel Company have passed inspection, leaving one set to be still delivered under their orders.

Of the two private works that are under contract to machine-finish and assemble forgings furnished by the Bureau, the South Boston Iron Works, of Boston, Mass., has received six sets of 6-inch forgings, and the West Point Foundry Association, of Cold Spring, N. Y., has received four sets. Both establishments have made satisfactory progress on their work, and will have several 6-inch guns finished ere long.

The forgings for 8-inch guns, to be machined by these companies, have just arrived from Sir Joseph Whitworth & Co., of Manchester, England. The parts are being prepared as rapidly as possible for shipment to the respective works.

This steel is more than a year overdue from the English maker, and the delay in its receipt furnishes an excellent argument for encouraging the establishment of heavy gun forging plant in the United States.

Two additional chase rings for each of the 8-inch guns of the Atlanta and Boston have recently been ordered from the Midvale Steel Company, and are yet to be received, after which these guns can be speedily finished.

The broadside carriages of the Atlanta and Boston are all finished, and the barbette-carriages are being pushed as rapidly as possible.

The brown powder for the great guns of the Atlanta has been ordered from the Rhenish Westphalian Company. It is hoped that that for the Boston and Chicago can be made in the United States.

The secondary batteries for these ships have mostly been delivered at the navy-yard, New York; the powder for them will be of domestic manufacture.

The search-light outfits have been all received.

ARMAMENT OF THE PROJECTED SHIPS.

When Congress at its last session appropriated for the construction of four additional vessels, there was no provision for their armament, but designs for their guns have all been made, and preliminary designs the carriages. They are shown in the Appendix.

The secondary batteries and other ordnance outfit will be purchased n money becomes available for that purpose.

ARMAMENT OF THE DOUBLE-TURRETED MONITORS.

The Miantonomoh is now being armored at New York. Her a ment should proceed at once. Two 10-inch guns are partly compl at the Washington navy-yard, which could serve for one of her turn but as they are to be subjected to a special test, pursuant to an act the last Congress, it has been thought best to include in the estimate submitted the whole four guns for the vessel.

In case work on the other double-turreted monitors is to be continued, the preparation of their armament should be undertaken at once, as it is likely to take quite as long to supply the guns, &c., as to finish the vessels in other respects. To this end estimates have been submitted.

ARMAMENT FOR CERTAIN SHIPS NOW IN SERVICE.

The third-rate ships last built are good sea boats, have compound engines, and are in most important respects good examples of the best class of wooden vessels. They will last some years and must be depended upon to do most of the work of the Navy until a sufficient number of new ships are built to replace them. It appears desirable that they should receive a modern armament, as the impression they produce without it is but slight. When they are finally replaced the armament will answer for newer vessels.

There are eight of the class referred to, but the Bureau has submitted estimates for six, assuming that two may become unserviceable before their armament could be prepared.

HIGH POWER MUSKET.

Since last report a new musket of this kind has been made for the Bureau. It was manufactured by the Winchester Repeating Arms Company, from specifications by Commander William M. Folger, and its power and simplicity are very satisfactory, though it is considered that the limit of the former quality has not yet been reached.

The maximum recorded velocity is 2,030 foot seconds, steel bullet 400 grains, charge of powder 200 grains. The bullet perforates 1 inch of steel (at short range) with reserve of force sufficient to kill two men. It penetrates 40 inches into 1-inch pine boards.

The piece weighs 12 pounds 2 ounces, and can be fired from the shoulder, but is intended in service to be fired with a rest. The accuracy not being as great as desired the weight of barrel will be increased. (For report on this arm see Appendix, page 232.)

CLARK'S DEFLECTIVE TURRET.

The Pusey & Jones Company, of Wilmington, Del., have finished fitting the plates, backing and bracing of the target representing a section of the Clark deflective turret, but the structure has not yet been set up at the naval ordnance proving-ground.

Owing to lack of funds it has not been possible to complete a 10-inch gun with which to test this target. The prospect is now that one will be completed ere long, when the structure will be put together and tested.

HE NAVAL ORDNANCE PROVING GROUND.

searches detailed in the foregoing pages as having been
he Naval Ordnance Proving Ground, that most useful
harge of Commander William M. Folger, U. S. N., has
a variety of work essential to the development of ord-
ns of the new armament thus far finished have been
customary number of rounds. Several classes of guns
ed, numerous trials have been made as to the best com-
per of steel for armor-piercing shells, and as to the re-
l plates (to the attack of projectiles) when treated by
ls.

ent of chamber pressures in the different classes of guns
ch attention; loading and reloading tools for light am-
been devised, gun platforms have been built, butts re-
get armor plates mounted and backed, machine-guns

additional to those of last year) have been made with
pered 3-inch projectiles of different forms of head, fired
gets inclined 14° to the line of fire.
ent to show that the cylindrical projectile (flathead)
effect. (See Appendix, page 233.)

E FOR NAVAL ORDNANCE PROVING GROUND.

location of the Proving Ground is certainly unsuitable
e more so as the development of ordnance progresses.
ntirely over water, and its use is embarrassed by the
a light-house near the batteries and of a large hotel
down the range, besides the number of oyster and fish-
are frequently anchored or moving about the range,
ve delays in the practice.
r range is not convenient and all projectiles fired on it
not possible to study the action and resistance of per-
r fuzes on the farther parts of the range, and projectiles
bands cannot be examined after flight.
of the present site are well set forth in the following
letter from the inspector of ordnance in charge:

* * * * * *

to the entire unsuitability of the position of the Proving Ground
n hand and in immediate prospect. The oyster industry of An-
ange crowded with small craft during eight months of the year,
suitable for my work is precisely that which the oysterman needs
m obliged either to drive these men from their fishing grounds,
rdship to them, or wait until after their return in the evening, for
re, which entails extra expense to the Bureau, the work thus done
ular hour for closing has passed.
s I have had of projectiles of smaller caliber leaving the butt,
ate much annoyance and even danger from this cause to Greens-
ouse and to vessels at anchor in the roadstead. I have had fre-
rom farmers in the neighborhood of fragments of projectiles pass-
ar their habitations.
een complaints from Horn Point of glass being broken and plast-
n from the violence of concussion at the discharge of the 6-inch
cessary to state that these effects will be much increased in work
s.
ommended that a more suitable position may be purchased by the
r that the needed experimental work and proof of guns may not
upted.

TORPEDO TRIALS.

As a consequence of the trials held before the torpedo board la the Bureau decided to make three automobile torpedoes on the de Capt. John A. Howell, U. S. N. Two of these were completed an were held partly in the Potomac and partly in the harbor of Ne R. I. The trials showed that the torpedo possesses valuable qu chief among which is its strong directive force and its compar small size. Unfortunately, these two torpedoes were lost, but (which was then nearly finished) will soon be completed, and tried in a location where the chances of its loss will be at a mini

SWIFT TORPEDO BOAT.

The purchase of a swift torpedo boat from one of the most cele makers abroad is again urged. Such craft combine qualities can only be judiciously united and skillfully and economically em by builders who have had large experience in this special bra construction.

There are several firms abroad that have had such experience. really fine boat purchased from one of them would furnish us ample of the utmost progress that has thus far been made in thi cult branch of construction, and could be examined and tested ship-builders, and would doubtless be a source of great benefit t in designing and competing for the numerous boats of this cl require immediately.

The size of these boats gradually increases abroad. A length feet has been thought sufficient heretofore, but now the more adv firms are building a length of 120 and 140 feet and more. Boat 200 feet long are being projected.

The sum asked for last year for a 110-foot boat has been inc so as to cover one of about 135 feet.

THE MEGAPHONE.

Last year the Bureau made a megaphone on a design by Lie A. Fiske, U. S. N., and placed it for trial on board of the U. S. S lapoosa. When that vessel was sunk the megaphone was lost, a definite conclusion was reached as to its useful qualities.

The Bureau has recently caused another one to be made on a by the same officer, and will have it embarked upon some ves order to ascertain its capabilities as a detector of the approach pedo boats and counterminers (or other military expeditions) by

The intensity of sounds is greatly augmented in the instrume practice will be required to use it to advantage. As its employ many of the circumstances of war might be very important, it is u well to give it a service trial.

A drawing will be found in the Appendix, page 229. It is ther bined with a large speaking trumpet.

APPARATUS FOR THE ELECTRICAL FIRING OF GREAT GU

The attention of Lieut. B. A. Fiske, U. S. N., has been dire the perfection of a suitable key-board "pistol" and connection used in the firing circuits on board the new steel ships for the ele firing of great guns.

Both instruments will be found figured and described at page the Appendix. They are strong and simple.

THE TORPEDO STATION

:n under the charge of Commander William T. Sampson, U. S. N., ovember 1, 1884.

nanufacture of gun cotton for the use of the Navy has been car- during the year, and the product continues as good as formerly. nsity has been somewhat increased, thereby gaining an increase osive force.

tendency of the finished product to mold has been a source of ouble, and efforts are making to prevent this action.

large magazines for the storage of gun cotton have been fitted Rose Island) in the uncompleted casemates of the old fort at that This enables us to remove the store of gun cotton from the orhood of the public quarters, the machine and other shops on sland, where the structures used are small and become too much in summer.

cotton for safe military use is usually wet with about 20 per cent. r. In this state it is most commonly detonated by means of a which is chiefly composed of dry gun cotton. This last being nsafe than the wet is a source of considerable care on board ship, r this reason it has been sought to carry none but wet gun and to find some ready means to quickly dry enough of it on n to answer for dry priming to the wet mass in the torpedo. A np stove has heretofore been used for this purpose, but as this ment is inconvenient some experiments were undertaken for the e of finding a simpler method. The trials are detailed in the Ap- , page 245, and have resulted in the use of calcium chloride, a nore convenient process than that in vogue heretofore.

boat fittings for spar torpedoes have been designed. thought that they will require less men for their use than those service, and are stronger; and extended trials are being held em.

nproved action of the spar torpedo can also be had by packing n-cotton in a solid mass (instead of in a cluster of cylinders as ore).

apparatus for "contact explosion" has also been made remova- it can be attached to any service torpedo.

s also been decided to substitute a compact form of voltaic bat- e Clanché) for the hand dynamo machine heretofore used for the on of spar torpedoes.

material embodying these designs and changes is shown and de- in the Appendix, pages 242, 244.

stock of machinery in the torpedo machine-shop is fair and in ondition, but the boiler of the shop is deficient in power, much rated, and will last but a very short time longer. The boiler of n-cotton factory is worn out. The Bureau has arranged to re- hem both, and the old boiler of the machine-shop will be used ting purposes.

l estimates for enlargement of the electrical laboratory, and one use for the manufacture of fuzes, have been submitted; both essary. Several valuable and necessary electrical instruments een received during the year.

Bureau wishes to call attention to the importance of furnishing on with at least two steam launches of modern form, engines, , with which to exercise the torpedo classes in the maneuvers y will be expected to practice in time of war. The launches

at the station are old, slow, and worn out. They are useless now for the purposes for which they were originally intended, and must be replaced if efficiency is to be maintained.

INSTRUCTION.

The usual summer course of instruction was given to comm officers and gunners in matters bearing upon torpedo warfare. A c of twenty-five officers was present, and their attention and progress are commended by Commander Sampson.

The Bureau had previously decided to make a number of alterat in the course of study, and in the manner of giving instruction. practical exercises were had than has heretofore been customary the course in theoretical electricity and chemistry was modified. the inspector and the Board of Visitors were gratified at the r and recommend a continuance of the new programme, which gives remarked, much prominence to practical instruction.

Much instruction was given in the management and care of circuits and apparatus for electric lighting. This branch of knowledge is very essential, as modern ships will doubtless all be lighted by electricity.

In connection with the above and with military lighting, much exercise has been had with high-speed engines and with dynamos.

In order to afford an opportunity of further study to those who, by reason of inclination, mental equipment, and other circumstances, are available for the purpose, a second or advanced course of instruction is arranged to immediately follow the general summer course. This advanced course extends over nine months, and the aim is to give higher instruction in the theory of the sciences that bear upon torpedo warfare. This year five officers take the advanced course. They were selected from the summer class on recommendation of the inspector of ordnance in charge.

A class of seamen gunners and continuous-service men is now under instruction at the station. The course extends over a term of six months, and embraces practical instruction in matters pertaining to the manufacture, care, and use of service-torpedo material.

The conduct, attention, and progress of the men is commended by the inspector of ordnance in charge.

For several years the Bureau has been giving instruction at the stat in submarine diving, an experienced instructor being employed each season for the purpose.

It is gratifying to find that the importance of this branch is appreciated by both officers and seamen, most of them having been down in the armor frequently. A practical acquaintance with submarine work will be a necessity for the torpedoist in time of war.

The report of the Board assembled by the Department to witn final examination of the summer torpedo class will be seen in the Appendix, page 250. It contains many good suggestions, and the desire of Board to give the Bureau unbiased criticism of the course of study exercises is highly appreciated.

TORPEDO SEARCH LIGHTS.

The exercises at the station have developed certain facts with r ence to powerful torpedo search lights, which Commander S dwells upon in his report.

He thinks that to be effective the lights must be mornted near water-line; that their usefulness is much abridged by even a

:he sea), and that numbers of lights should be used in-

espect his experience is similar to that of officers abroad imented in the same direction, and it is probable that on in the use of search lights will be introduced ere long. a greater number of less individual power will be found han the few powerful ones now in use.

ısion of his report Commander Sampson makes a few ıs of general naval interest.

points he touches are such as naval officers have long on. This Bureau has (in substance) repeatedly urged ıer more or less modified to meet the probabilities of equisite appropriations, and some of them have a place ordnance estimates.

Sampson's report will be found in the Appendix, page en with his usual ability, and his administration of the during the year has been eminently satisfactory to the

statements are appended, viz:

ıowing amount appropriated under each specific head of appropri- ce of the Bureau of Ordnance, during the year ending June 30, ı during the same period and balance remaining on hand June 30, pended for material and labor, and what balance will be required g obligations made during the year.

f cost or estimated value of stores under the cognizance of the e on hand at the several navy yards July 1, 1884—of articles re- ed from July 1, 1884 to June 30, 1885, and of those remaining on

f the number of days labor and cost thereof, from July 1, 1884, to he respective navy-yards and stations, chargeable to the Bureau

ended during the fiscal year ending June 30, 1885, from the appro- Bureau of Ordnance for civilians employed on clerical duty, or ity than as ordinary mechanics and workingmen.

sales at public auction of condemned material under the cogni au of Ordnance, during the year ending June 30, 1885, and net ıerefror

contracts entered into by the Bureau of Ordnance during the year 35.

your obedient servant,

MONTGOMERY SICARD,
Chief of Bureau.

WHITNEY,
retary of the Navy.

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ng amount appropriated under each specific head of appropriation for ureau of Ordnance during the fiscal year ending June 30, 1885, expendi- me period, and balance remaining on hand June 30, 1885.

propriation.	Appropriated.	Expended.	Balance June 30, 1885.
	$125,0[illegible]	$117,7[illegible]	$7,263 12
	41,65[illegible] 50	40,9[illegible] 99	729 51
	15,[illegible]	9,[illegible] 52	5,485 48
	3,[illegible]	3,[illegible]	
	5,[illegible]	4,99[illegible] 84	8 16
	50,[illegible]	43,[illegible] 13	6,162 87
e	500,[illegible]	308,30[illegible] 32	191,693 68
	739,6[illegible] 50	528,289 68	21[illegible],342 82

The amounts expended were—

For labor	$252,740 [illegible]
For material, &c	275,549 [illegible]
	528,2[illegible] [illegible]

The balances remaining are all required to meet outstanding obligations except the balance under appropriation "Civil Establishment," $8.16.

B.—*Statement of cost or estimated value of stores on hand at the several navy-yards July 1, 1884, of articles received and expended from July 1, 1884, to June 30, 1885, and of those remaining on hand July 1, 1885, which are under the cognizance of the Bureau of Ordnance.*

Navy-yard.	On hand July 1, 1884.	Receipts.	Expended.	On hand July 1, 1885.
Portsmouth	$656,690 40	$69,175 40	$130,194 10	$595,671 [illegible]
Boston	2,331,438 34	1,492 30	5,219 33	2,327,711 [illegible]
New York	3,112,763 59	329,979 22	132,921 42	3,309,821 [illegible]
League Island	915,010 50	903 34	3,106 44	912,8[illegible] [illegible]
Washington	1,209,922 13	348,152 58	212,453 20	1,345,621 [illegible]
Norfolk	794,051 22	52,136 37	102,463 08	743,724 [illegible]
Pensacola	305,084 53	207 35	1,386 37	303,946 [illegible]
Mare Island	1,601,695 58	34,130 91	63,151 32	2,572,673 17
Naval Ordnance Proving Ground, Annapolis	120,067 01	69,811 87	46,096 00	143,782 [illegible]
Torpedo station	32,230 41	58,777 69	59,560 71	31,447 [illegible]
Total	11,078,953 71	964,767 03	756,551 97	11,287,168 77

C.—*Statement of the number of days labor, and cost thereof, from July 1, 1884, to June 30, 1885, at the respective navy-yards, chargable to the Bureau of Ordnance.*

Navy-yard.	Number of days labor.	Cost of same.
Portsmouth, N. H	1,371½	$3,4[illegible] [illegible]
Boston	1,286⅝	2,8[illegible] [illegible]
New York	8,013	19,135 [illegible]
League Island	889	1,[illegible] [illegible]
Washington	79,658	177,[illegible] [illegible]
Norfolk	3,933½	7,973 [illegible]
Pensacola	302	4[illegible] [illegible]
Mare Island	4,341½	10,[illegible] 11
Key West	31	75 [illegible]
Naval Ordnance Proving Ground, Annapolis	7,726½	9,973 [illegible]
Torpedo station	6,855¾	18,[illegible] [illegible]
Total	114,408¼	252,[illegible] [illegible]

NOTE.—This table includes the following amounts which are not included in Table A:

At Naval Ordnance Proving Ground, Annapolis, from appropriation "testing Clark's deflective turrets"	$111 [illegible]
At Washington navy-yard, from appropriation "testing Clark's deflective turrets"	27 [illegible]
At New York navy-yard, from appropriation "Relief of Lady Franklin Bay Expedition"	[illegible] [illegible]
	21[illegible] [illegible]

.—Amount expended during the fiscal year ending June 30, 1885, from the appropriations under the Bureau of Ordnance for civilians employed on clerical duty, or in any other capacity than as ordinary mechanics and workingmen.

Navy-yard.	Rating.	Amount paid.
Portsmouth, N. H	1 storekeeper	$927 00
Boston	1 writer (60 days)	195 60
New York	1 clerk	1,400 00
	1 storekeeper	871 50
	1 messenger	755 03
	1 master of tugs (3½ months)	444 87
League Island	1 storekeeper	801 62
Washington	1 clerk	1,500 00
	1 foreman	2,100 00
	1 quarterman	1,228 00
	......do	987 56
	......do	936 98
	1 leading man	1,064 00
	......do	1,039 50
	4 temporary leading men	531 04
	1 draftsman	1,232 00
	......do	819 00
	1 draftsman (6½ months)	500 00
	1 draftsman	936 00
	1 assistant draftsman	741 25
	1 storekeeper	997 32
	1 special ordnance man	917 76
	1 office boy	323 00
Norfolk	1 clerk	1,200 00
Mare Island	1 writer	891 84
	1 storekeeper	125 40
	1 draftsman (4 days)	24 00
	1 pilot (2 days)	6 00
Naval Ordnance Proving Ground, Annapolis	1 storekeeper (15 days)	37 50
Torpedo station	1 chemist	2,241 10
	1 clerk	1,184 00
	1 draftsman	1,170 63
	1 writer (42 days)	126 00
	1 submarine diver (4 days)	40 00
	Total	28,295 50

E.—*Statement of sales at public auction of condemned material under the cognizance of the Bureau of Ordnance during the year ending June 30, 1885, and net amounts realized therefrom.*

1884.	
August 30. Condemned stores at Rio Janeiro, Brazil, by Passed Assistant Paymaster J. R. Martin	$263 66
October 10. Yoke of oxen at Naval Ordnance Proving Ground, Annapolis, by Paymaster F. H. Arms	65 80
1885.	
January 5. Condemned material at Mare Island navy-yard, by Paymaster J. B. Redfield	502 02
1884.	
November 13. Condemned stores at naval depot, Nagasaki, Japan, by Paymaster J. C. Sullivan	1,675 33
1885.	
January 5. Condemned material at navy-yard, Pensacola, by Paymaster A. Peterson	368 39
Total net proceeds	2,875 20

The names of the parties purchasing the above have not been reported to the Bureau.

F.—*Statement of contracts made by the Bureau of Ordnance during the year ending June 30, 1885.*

7. 84, with the West Point Foundry Association, of Cold Spring,	
... the construction of 5 6-inch and 2 8-inch rifles	$35,000 00
bid the above work was	37,000 00
the uth Boston Iron Works, Boston, Mass., for the	
2 8-inch rifles	38,600 00
was	40,800 00

Estimates of appropriations required for the service of the fiscal year ending June by the Bureau of Ordnance, Navy Department.

Detailed objects of expenditure, and explanations.	Estimated amount which will be required for each detailed object of expenditure.	Amount appropriated for the current fiscal year ending June 30, 188[illegible]
SALARIES.		
Chief clerk (Mar. 3, 1885; R. S., 23, p. 70, sec. 416, p. 415)	$1,800 00	
Draughtsman (Mar. 3, 1885; R. S., 23, p. 27, sec. 167, p. 415)	1,800 00	
One clerk of class three (Mar. 3, 1885; R. S., 23, p. 27, sec. 167, p. 415)	1,600 00	
One clerk of class two (Mar. 3, 1885; R. S., 23, p. 27, sec. 167, p. 415)	1,400 00	
One clerk at $1,000 (Mar. 3, 1885; R. S., 23, p. 415)	1,000 00	
One assistant messenger (Mar. 3, 1885; R. S., 23, p. 27, sec. 167, p. 415)	720 00	
One laborer (Mar. 3, 1885; R. S., 23, p. 27, sec. 167, p. 415)	660 00	
	8,980 00	$8,[illegible]
Increase submitted:		
To salary of chief clerk	450 00	
NOTE.—The chief clerk is required by law to act as Chief of Bureau, in case of vacancy or of the absence or sickness of that officer (in case no other appointment is made). His duties are as responsible and arduous as those of the chief clerks in the other Executive Departments who are required by law to perform the same functions, and who now receive a like compensation, viz, $2,250 per annum.		
By promotion of above clerk of class three to clerk of class four	200 00	
One clerk of class one	1,200 00	
One copyist	900 00	
	2,750 00	
NOTE.—The work of the Bureau has increased greatly of late years, owing to the increasing elaboration of ordnance material, and the additional clerk and copyist asked for are needed.		
ORDNANCE AND ORDNANCE STORES.		
For procuring, producing, and preserving ordnance material; for the armament of ships; for fuel, tools, material, and labor to be used in the general work of the Ordnance Department; for furniture at magazines, at the ordnance dock New York, and at the naval ordnance battery and proving gound (appropriated; R. S., 23, p. 427, sec. 1)	177,500 00	
Main and secondary batteries complete, of the new types, for six of the ships now in service (submitted)	670,000 00	
Towards the general armament of the Navy with modern secondary batteries and small arms—		
30 machine cannon of modern caliber	93,000 00	
20 musket caliber machine-guns	55,000 00	
1,000 magazine rifles, equipments and ammunition	34,750 00	
400 naval cadet rifles	6,000 00	
200 revolvers and ammunition	3,500 00	
Proof of naval guns and their appendages	6,000 00	
Modern armament of two practice vessels for the training squadron	10,000 00	
Purchase of land for proving and ranging ground for naval guns, and for constructing buildings, butts, shelters, batteries, &c	57,000 00	
Total	1,112,750 00	
REPAIRS ORDNANCE.		
Necessary repairs to ordnance buildings, magazines, gun parks, boats, lighters, wharves, machinery, and other objects of the like nature (appropriated; R. S., 23, p. 427, sec. 1)	15,000 00	
CONTINGENT.		
Miscellaneous items, viz: For freight to foreign and home stations; advertising and auctioneers' fees; cartage and express charges; repairs to fire-engines; gas and water pipes; gas and water tax at magazines; toll, ferriage, foreign postage and telegrams to and from the Bureau, &c. (appropriated; R. S. 23, p. 427, sec. 1)	5,000 00	[illegible]
NOTE.—The Bureau again calls attention to the insufficiency of the amounts heretofore appropriated for the above objects. A deficiency of $1,300 will accrue under this head (for the year 1884-'85) which it has been impossible to foresee.		
CIVIL ESTABLISHMENT.		
For the civil establishment under the Bureau of Ordnance, viz:		
Navy-yard, Portsmouth, N. H.:		
One writer (appropriated; R. S. 23, p. 427, sec. 1)	1,017 25	
Navy-yard, Boston, Mass.:		
One writer (appropriated; R. S. 23, p. 427, sec. 1)	1,017 25	

Estimates of appropriations required for the service of the fiscal year, &c.—Continued.

General object of expenditure, and explanations.	Estimated amount which will be required for each detailed object of expenditure.	Amount appropriated for the current fiscal year ending June 30, 1886.
NAVY-YARD, NEW YORK.		
ne clerk (appropriated; R. S. 23, p. 427, sec. 1)	$1,400 00	
ne writer (appropriated, R. S. 23, p. 427, sec. 1)	1,017 25	
NAVY-YARD, WASHINGTON, D. C.		
ne clerk (appropriated; R. S. 23, p. 427, sec. 1)	1,600 00	
ne writer (appropriated; R. S. 23, p. 427, sec. 1)	1,017 25	
ne writer (appropriated; R. S. 23, p. 427, sec. 1)	1,017 25	
ne draftsman (appropriated; R. S. 23, p. 427, sec. 1)	1,545 00	
ne draftsman (appropriated, R. S. 23, p. 427, sec. 1)	1,081 00	
ne draftsman (appropriated, R. S. 23, p. 427, sec. 1)	1,081 00	
ne draftsman (appropriated; R. S. 23, p. 427, sec. 1)	927 00	
ne assistant draftsman (appropriated, R. S. 23, p. 427, sec. 1)	772 00	
ne foreman (appropriated; R. S. 23, p. 427, sec. 1)	2,155 00	
NAVY-YARD, NORFOLK, VA.		
ne clerk (appropriated; R. S. 23, p. 427, sec. 1)	1,200 00	
NAVY-YARD, MARE ISLAND, CAL.		
ne writer (appropriated; R. S. 23, p. 427, sec. 1)	1,017 25	
NAVAL ORDNANCE PROVING GROUND, ANNAPOLIS, MD.		
ne writer (appropriated, R. S., 23, p. 427, sec. 1)	1,017 25	
TORPEDO STATION, NEWPORT, R. I.		
ne chemist (appropriated R. S., 23, p. 427 sec. 1)	2,240 00	
ne clerk (appropriated R. S., 23, p. 427, sec. 1)	1,200 00	
ne draughtsman (appropriated, R. S., 23, p. 427, sec. 1)	1,500 00	
	23,822 75	$5,000 00
NOTE.—The above estimate is made to conform to section 3 act approved January 30 1885, and includes those heretofore employed and paid from appropriations "Ordnance" and "Torpedo Corps." The clerk at New York, Washington, and Norfolk and the writer at Mare Island, only have been paid from "Civil Establishment" during the past year.		
TORPEDO CORPS.		
Labor, material, freight and express charges, general care of and repairs to grounds, buildings, wharves, &c. boats, instruction instruments, tools, furniture, experiments, and general torpedo outfits (appropriated, R. S., 23, p. 428, sec. 1)	65,000 00	
For new ferry launch (submitted)	7,000 00	
NOTE.—The present ferry launch has been in continuous use for many years, will not last much longer, and requires extensive repairs. At such times as she is under repairs there is no suitable boat to relieve her. The only regular communication with the mainland is by this ferry (submitted).		
For two new boilers and setting (submitted)	2,500 00	
NOTE.—The present boiler for running the machine shop is badly corroded and cannot much longer perform the work it is required to do. The boiler of the gun cotton factory is entirely worn out.		
Building fuze room with drying apparatus (submitted)	700 00	
Building coal shed (submitted)	300 00	
Purchase of a torpedo-boat and the working drawings of the same (submitted)	75,000 00	
NOTE.—The purchase of a fast torpedo boat from one of the leading builders of the world will furnish our people with a type and example of the most advanced form of construction. This is a matter of the first importance.		
For the purchase of auto-mobile torpedoes of the latest construction, and a set of launching apparatus, with working drawings therefor (submitted)	100,000 00	
	250,500 00	60,000 00

NOTE.—The United States has no practical auto-mobile torpedo suitable for general use in warfare afloat, and is the only nation of any pretensions which is not thus provided.

***Estimates of appropriations required for the service of the fiscal year, &c.*—Continued.**

General object of expenditure, and explanations.	Estimated amount which will be required for each detailed object of expenditure.	Amount appropriated for the current fiscal year ending June 30, 1886.
DOUBLE-TURRETED MONITORS—ORDNANCE.		
Amount required to supply the ordnance outfit of the Miantonomoh (now being armored) (submitted)	$207,000 00	
To supply the ordnance outfits of the monitors Puritan, Terror, Amphitrite, and Monadnock (submitted)	866,000 00	
	1,073,000 00	
NOTE.—No torpedo outfit is estimated for. If an auto-mobile, similar to the Whitehead, should be used, $100,000 additional would be necessary.		
STEEL RIFLED BREECH LOADING GUNS.		
One 12-inch breech loading rifle (submitted)	60,000 00	......
NOTE.—In making the above estimates, the price of English steel has been used in calculating the cost of all 8-inch and 10-inch guns. If American steel could be used, the price of the steel *for these calibers* would be increased fifty per cent., making an increase in the estimate of about $120,000.		
INCREASE OF THE NAVY—ORDNANCE.		
For the armament of the new vessels authorized by act approved March 3, 1885, viz:		
One cruiser of between 3,000 and 5,000 tons (submitted)	294,892	
One cruiser of between 3,000 and 5,000 tons (submitted)	306,428	
One heavily-armed gunboat of 1,600 tons (submitted)	188,098	
One light gunboat of 800 tons (submitted)	89,352	
	878,770	
MACHINERY FOR ORDNANCE.		
Towards the purchase and manufacture of improved and more powerful machinery for the fabrication of cannon, &c. (submitted)	50,000	

...s of appropriations for deficiency required for the service of the fiscal year ending June 30, 1885, by the Bureau of Ordnance, Navy Department.

...ised Statutes, title 41, page 720, sections 3660 to 3671; Statutes 18, chapter 129, page 370, section 3, act of March 3, 1875, and section 2, deficiency act of July 7, 1884.]

Detailed objects of expenditure, and explanations.	Estimated amount which will be required for each detailed object of expenditure.	Amount appropriated for the current fiscal year ending June 30, 1884.
CONTINGENT, ORDNANCE.		
...y a deficiency in the contingent service of the Bureau for the ...ear ending June 30, 1885 (July 7, 1884, R. S. 24, p. 262)	$1,800 00	$3,000 00
–The Bureau has been unable to confine itself within the appro... ...of $3,000, the freight, advertising, and other bills at home and on ...tations having been unusually heavy. It has unpaid bills in ...ounting to $1,157, $693.24 of which was incurred on account of ...ation for the expedition to Aspinwall. The amount required ...des bills incurred on foreign stations, with the estimated amount ...yet likely to come in from abroad.		
STEEL CRUISERS.		
...up a deficiency to cover obligations incurred by this Bureau for ...ament of the steel cruisers authorized by act of March 3, 1883, ...ade available immediately (March 3, 1883; R. S., 23, p. 477)	193,000 00	
–By the act referred to $1,300,000 was appropriated towards the ...tion of steel cruisers, $234,000 of this sum was allotted by the ...partment to this Bureau towards procuring the armament. ...quently the Department withdrew $193,000 of this allotment, ...was understood was to be given to other Bureaus. ...ne to the withdrawal, obligations had been incurred (by Ord... ...overing the whole of the sum thus withdrawn, and as a new ap... ...on bill was pending, it was supposed that the Bureaus which ...the $193,000 would ask for that amount for the purpose of repay... ...lnance." ...owever, was not done, and therefore a deficiency exists to the ...stated.		

...tfully submitted.

MONTGOMERY SICARD,
Chief of Bureau of Ordnance.

...t, 1885.

Manufactures and preparations at the navy-yards and stations for the year ending J 30, 1885.

ARTICLES UNDER PROPORTION TO EACH GUN.

7 8-inch M. L. R. sponge-covers, sheepskin.
2 8-inch M. L. R. straps, securing.
10 8-inch M. L. R. shrapnel.
37 8-inch M. L. R. shell.
1 8-inch M. L. R. rammer.
1 8-inch M. L. R. rammer-head.
30 8-inch M. L. R. tackles.
6 8-inch M. L. R. breechings.
1 set 8-inch M. L. R. taps and dies.
10 8-inch M. L. R. sponge-caps, canvas.
4 sets 8-inch M. L. R. gun-gripes.
1 8-inch M. L. R. impression instrument.
2 8-inch M. L. R. muzzle-bags.
3 8-inch M. L. R. sponges, bristle.
12 IX-inch M. L. S. B. wash-deck chocks.
181 IX-inch M. L. S. B. tackles.
22 IX-inch M. L. S. B. train-tackles.
53 IX-inch M. L. S. B. sponge-covers, canvas.
95 IX-inch M. L. S. B. sheepskin sponge-covers.
2 IX-inch M. L. S. B. sponges, sheepskin.
52 IX-inch M. L. S. B. muzzle bags.
87 IX-inch M. L. S. B. breechings.
1 XI-inch M. L. S. B. breeching.
2 sets XI-inch M. L. S. B. breechings, preventer.
6 VIII-inch M. L. S. B. sponge covers, sheepskin.
6 32-pounder M. L. S. B. covers for sponge head.
370 6-inch B. L. R. S. shell.
10 6-inch B. L. R. S. shrapnel, iron.
5 6-inch B. L. R. S. pivot bolts.
4 8-inch B. L. R. S. mushrooms.
1 6-inch B. L. R. S. mushroom nose plate and stem.
6 6-inch B. L. R. S. shot, steel.
1 6-inch B. L. R. S. loading scoop.
1 6-inch B. L. R. S. passing box.
8 6-inch B. L. R. S. sponges, sheepskin.
7 6-inch B. L. R. S. sponges, bristle.
280 6-inch B. L. R. S. shell boxes.
5 6-inch B. L. R. S. shot boxes.
2 6-inch B. L. R. S. impression instruments.
3 6-inch B. L. R. S. drill cartridges.
1 6-inch B. L. R. S. carriage, Dolphin.
1 6-inch B. L. R. S. carriage, gravity return.
3 6-inch B. L. R. S. carriages, broadside.
5 6-inch B. L. R. S. hooped.
1 6-inch B. L. R. S. pivot yoke.
1 set 6-inch B. L. R. S. pivot circles.
4 6-inch B. L. R. S. pivot-yoke bolts.
6 6-inch B. L. R. S. clevis bolts.
1 set 6-inch B. L. R. S. gun gripes.
668 6-inch B. L. R. S. pivot-circle screws.
1 6-inch B. L. R. S. breech-cover.
3 6-inch B. L. R. S. gas checks.
4 6-inch B. L. R. S. shell gauges.
1 6-inch B. L. R. S. pivot-socket.
3 6-inch B. L. R. S. tackles, shifting.
3 6-inch B. L. R. S. rammers.
1 6-inch B. L. R. S. gun-sling, chain.
2 6-inch B. L. R. S. tackles, out.
2 6-inch B. L. R. S. tackles, in.
1 6-inch B. L. R. S. tompion.
6 6-inch B. L. R. S. firing attachment.
2 6-inch B. L. R. S. sponge-covers, sheepskin.
3 6-inch B. L. R. S. sponge-caps, canvas.
25 6-inch B. L. R. S. mushrooms.
1 6-inch B. L. R. S. breech-sight.

3 6-inch B. L. R. S. breechings, wire.
2 6-inch B. L. R. S. cup gas checks.
1 set 6-inch B. L. R. S. elevating gear.
4 5-inch B. L. R. S. gas-check pass.
2 5-inch B. L. R. S. hooped.
2 5-inch B. L. R. S. trunnion sleeves.
1 5-inch B. L. R. S. mushroom.
51 5-inch B. L. R. S. shell.
1 5-inch B. L. R. S. rammer head, bronze.
3 5-inch B. L. R. S. sponges, sheepskin.
3 5-inch B. L. R. S. sponge covers, sheepskin.
1 5-inch B. L. R. S. rammer, wood,
3 5-inch B. L. R. S. sponges, bristle.
6 5-inch B. L. R. S. sponge caps, canvas.
2 80-pounder B. L. R. P. sheepskin sponge covers.
276 80-pounder B. L. R. P. boxes, shot and shell.
2 sets 80-pounder B. L. R. P. elevating gear.
1 80-pounder B. L. R. P. Broadwell ring extractor.
1 80-pounder B. L. R. P. rammer head.
4 80-pounder B. L. R. P. breech sights.
4 80-pounder B. L. R. P. rim-base sights.
2 80-pounder B. L. R. P. breech covers, canvass.
2 sets 80-pounder B. L. R. P. trunnion seats and cap squares.
2 80-pounder B. L. R. P. shell loaders.
1 80-pounder B. L. R. P. Broadwell ring.
1 60-pounder B. L. R. P. rammer head.
3 60-pounder B. L. R. P. securing straps.
8 60-pounder B. L. R. P train ropes.
2 60-pounder B. L. R. P. sponges, bristle.
3 60-pounder B. L. R. P. cup gas checks.
5 60-pounder B. L. R. P. tackles, out.
3 60-pounder B. L. R. P. tackles, in.
8 60 pounder B. L. R. P. sheepskin sponge covers.
1 60-pounder B. L. R. P. firing attachment.
4 60-pounder B. L. R. P. pivot sockets.
6 60-pounder B. L. R. P. sponge caps, canvas.
1 60-pounder B. L. R. P. combination toggle:
2 60-pounder B. L. R. P. sights, rim base.
7 60-pounder B. L. R. P. breechings.
2 60-pounder B. L. R. P. boxes breech sight.
2 60-pounder B. L. R. P. breech-sight bars.
3 sets 60-pounder B. L. R. P. sights.
14 60-pounder B. L. R. P. shell.
4 60-pounder B. L. R. P. breech covers.
204 60-pounder B. L. R. P. boxes, shell.
6 sets 60-pounder B. L. R. P. gun gripes.
100 30-pounder B. L. R. P. shell boxes.
2 30-pounder B. L. R. P. sponges, sheepskin.
6 30-pounder B. L. R. P. cup gas checks.
3 30-pounder B. L. R. P. tompions.
9 30-pounder B. L. R. P. breeching thimbles.
2 30-pounder B. L. R. P. vent impressions.
10 30-pounder B. L. R. P. tackles, side.
6 30-pounder B. L. R. P. tackles, train.
12 30-pounder B. L. R. P. quoins, chocking.
3 30-pounder B. L. R. P. covers, sheepskin sponge.
6 30-pounder B. L. R. P. loading scoops.
4 30-pounder B. L. R. P. small-arm attachments.
5 30-pounder B. L. R. P. elevating screws.
3 30-pounder B. L. R. P. nose-plate wrenches.
8 30-pounder B. L. R. P. breechings.
4 20-pounder B. L. R. B. breechings.
8 20-pounder B. L. R. B. sheepskin covers for sponge heads.
11 20-pounder B. L. R. B. sponge caps, canvas.
18 handspikes, ordinary.
43 handspikes, roller.
6 division bags.
1 gas check, 9-inch.
4 impression takers.
1 stop-leak mat.

7 division tubs.
73 buckets, fire.
1 electric firing attachment.
14 shel stands on bulwarks.
1 circuit closer for gun captaine.
2 plans of magazine and shell rooms.
16 wash deck chocks.
39 quoins, chocking.
12 supply and reserve boxes.
30 swabs, gun.
51 selvagees for breeching.
6 targets, great gun.
12 sweep pieces.
23 shell whips.
23 sponges.
2 breast pieces.
6 bristle sponge heads.

HOWITZERS, MACHINE GUNS, EQUIPMENTS, ETC.

4 3-inch B. L. H. impression instruments.
1 3-inch B. L. H. dismounting bar.
1,086 3-inch B. L. H. shell sabots.
20 3-inch B. L. H. train ropes.
3 3-inch B. L. H. field-carriage wheels.
349 3-inch B. L. H. shrapnel.
694 3-inch B. L. H shell.
20 3-inch B L. H. tackles.
4 3-inch B. L. H. check ropes.
2 3-inch B. L. H. drag ropes.
80 3-inch B. L. H. shell boxes.
1 3-inch B. L. H. gun box.
15 3-inch B. L. H. screws, elevating.
12 3-inch B. L. H. handspikes, roller.
14 3-inch B. L. H. dummy shot.
13 3-inch B. L. H. hooks, drag rope.
28 3-inch B. L. H. blocks, metal
29 3-inch B. L. H. sponge caps, canvas.
12 3-inch B. L. H. sponges, bristle.
8 3-inch B. L. H. rammer and sponges.
716 3-inch B. L. H. shell plugs.
4 3-inch B. L. H. haversacks.
886 3-inch B. L. H. followers.
8 3-inch B. L. H. pivot sockets.
3 3-inch B. L. H. sponge buckets.
1 3-inch B. L. H. pivot bolt.
1 3-inch B. L. H. cup gas check box.
1 3-inch B L. H. hand grip.
1 3-inch B. L. H. gun cover.
3 12 pounder H. sheepskin sponge covers.
3 12 pounder H. sponge caps, canvas.
19 12-pounder rifle howitzer canister
4 24-pounder howitzer sweep pieces.
1 Hotchkiss 37^{mm}. revolving cannon chamber gauge.
1 Hotchkiss 47^{mm}. revolving cannon chamber gauge.
4 Hotchkiss cannon core mounts.
1 Hotchkiss cannon bristle sponge staff.
8 Hotchkiss 37^{mm}. cannon tripod mounts.
1 Hotchkiss 37^{mm}. revolving cannon cover.
1 Hotchkiss cannon tower mount.
1 Gatling gun cover.
2 Gatling gun drag ropes.
1 Gatling gun feed-case box.
2 Gatling gun check ropes.
1 Gatling gun haversack.
3 Gatling gun tripods.
2 arm chests, small.
1 set target screens.
1 set circles, tower mount.
33 chocks, deck field carriage.
1 shifting chock, boat carriage.

SMALL ARMS.

100 frogs, pistol.
30 frogs, revolver.
300 cutlass scabbards.
52 single sticks.
7 target plates.
20,000 balls, rifle, caliber .45.

MAGAZINE STORES.

174 8-inch M. L. R. cartridge bags, 25 pounds.
336 8-inch M. L. R. cartridge bags, 30 pounds.
50 8-inch M. L. R. cartridge bags, 40 pounds.
448 8-inch M. L. R., burster bags.
40 8-inch B. L. R. S. powder cylinders.
270 VIII-inch (6,500 pounds) cartridge bags, 5 pounds.
64 VIII-inch (6,500 pounds) cartridge bags, 6 pounds.
270 VIII-inch (6,500 pounds) cartridge bags, 7 pounds.
320 80-pounder B. L. R. cartridge bags.
199 80-pounder B. L. R. bags, burster.
200 60-pounder B. L R. cartridge bags.
51 60-pounder B. L. R. cartridge bags, 10 pounds.
120 60-pounder B. L. R. cartridge bags, 8 pounds.
223 60-pounder B. L. R. cartridge bags, 6 pounds.
1,281 60-pounder B. L. R. burster bags.
720 30-pounder B. L. R. burster bags.
410 30-pounder B. L. R. cartridge bags.
9,918 20-pounder B. L. R. B. cartridge bags.
400 20-pounder B. L. R. P. cartridge bags.
4,443 20-pounder B. L. R. B. followers.
1,400 20-pounder B. L. R. P. followers.
300 32-pounder M. L. S. B. cartridge boxes, 3 pounds.
250 32-pounder M. L. S. B. cartridge bags, 6 pounds.
700 32-pounder M: L. S. B. cartridge-bags, 4 pounds.
265 6-inch B. L. R. S. cartridge-bags.
50 6-inch B. L. R. S. burster-bags.
50 5-inch B. L. R. S. cartridge-bags.
995 3-inch B. L. H. cartridge-bags, 12 ounces.
635 3-inch B. L. H. cartridge-bags, 1 pound.
16 3-inch B. L. H. shrapnel charges.
130 3-inch B. L. H. bags, shell charge.
387 3-inch B. L. H. charges, saluting.
1 3-inch B. L. H. funnel.
220 12-pounder howitzer cartridge-bags, 10 ounces.
500 12-pounder howitzer cartridge-bags, 1 pound.
1,414 primers, shell, vent-closing.
55 blocks for steel vent-closing primers.
1 box for reloading tools, steel vent-closing primer.
9,473 primers, quill friction.
6 primers for percussion spring firing attachment.
4,779 fuses, Navy M. S. spherical.
560 fuses, Navy M. S. rifle.
1,251 fuses, Boxer.
52 stocks, Boxer fuse.
52 igniters, Boxer fuse.
10 fuses, base, experimental.
1,837 fuses, Bormann.
6,469 stocks, Bormann fuse.
5,100 rings, Bormann fuse stock.
660 adapters, fuse.
11 powder measures.
2 powder funnels.
2 powder chutes.
11 powder whips.
5 magazine hose.
8 magazine screens.
3 magazine candlesticks.
12 magazine dresses.
1 funnel, shell.

24 magazine lantern reflectors.
1 charger shell, 8 ounces.
1 charger shrapnel, 2½ ounces.
2 formers, cartridge-bag, 5-inch and 6-inch.
2 formers, cartridge bag, 60 and 80 pounders.
3 bags, cartridge, samples, 6-inch, 80 and 60 pounders.

MISCELLANEOUS.

1 8-inch model powder cylinder.
1 model gun and mount, Gatling.
25 specimens, 10-inch B. L. R.
4 tin cans.
3 water cans.
124 boxes, packing.
4 models of magazine, Lee rifle.
4 port sill sockets.
1 cover for deck-house launch.
1 shoe for cat-boat.
46 blocks, metal, large.
2 plates for powder pellets.
2 bullet molds.
1 set torpedo guys.
3 water-buckets.
8 castings, shot-bed.
2 steel rings, 10-inch B. L. R.
2 models, 6-inch powder cylinder.
1 toggle-block, 6-inch.
4 blocks for powder and shell whips.
1 gauge, 6-inch shell, inspecting.
1 gauge, 6-inch cartridge-bag.
8 drawing-boards.
26 castings, bronze.
24 cleats, breeching, beam.
13 steady rests.
1 lathe.
8 cranes.
1 former, revolver frogs.
102 lanyards, fire bucket.
473 lanyards, port.
200 lanyards, lock.
99 pounds lock lanyard stuff.
13,518 pounds bar-iron.
7,775 pounds bloom-iron.
20 specimens, metal.
1 pendulum, ship's.
1 stamp, anchor, ⅝ inch.
1 stamp, steel, ¼ inch.
1 speaking-tube.
1 compound target plate.
3 wooden cases.
121 rings, fire and sponge buckets.
1 percussion spring firing attachment.
220 rings, cartridge bag, 12-pounder light.
500 rings, cartridge bag, 24-pounder howitzer.
2 gun covers.
2 oil-tanks.
17 tallies for keys.
1 sail for boat.
115 lead vent-patches.
1 former, tinsmith's.
500 feet battens.
175 feet ash scotchman.
100 lids, shell-box.
1 cover, canvas, for dynamo.
3 boxes.
2 pairs beam calipers, 40 inches.
1 pair beam calipers, 20 inches.
2 shackle-plates, nuts and washers.

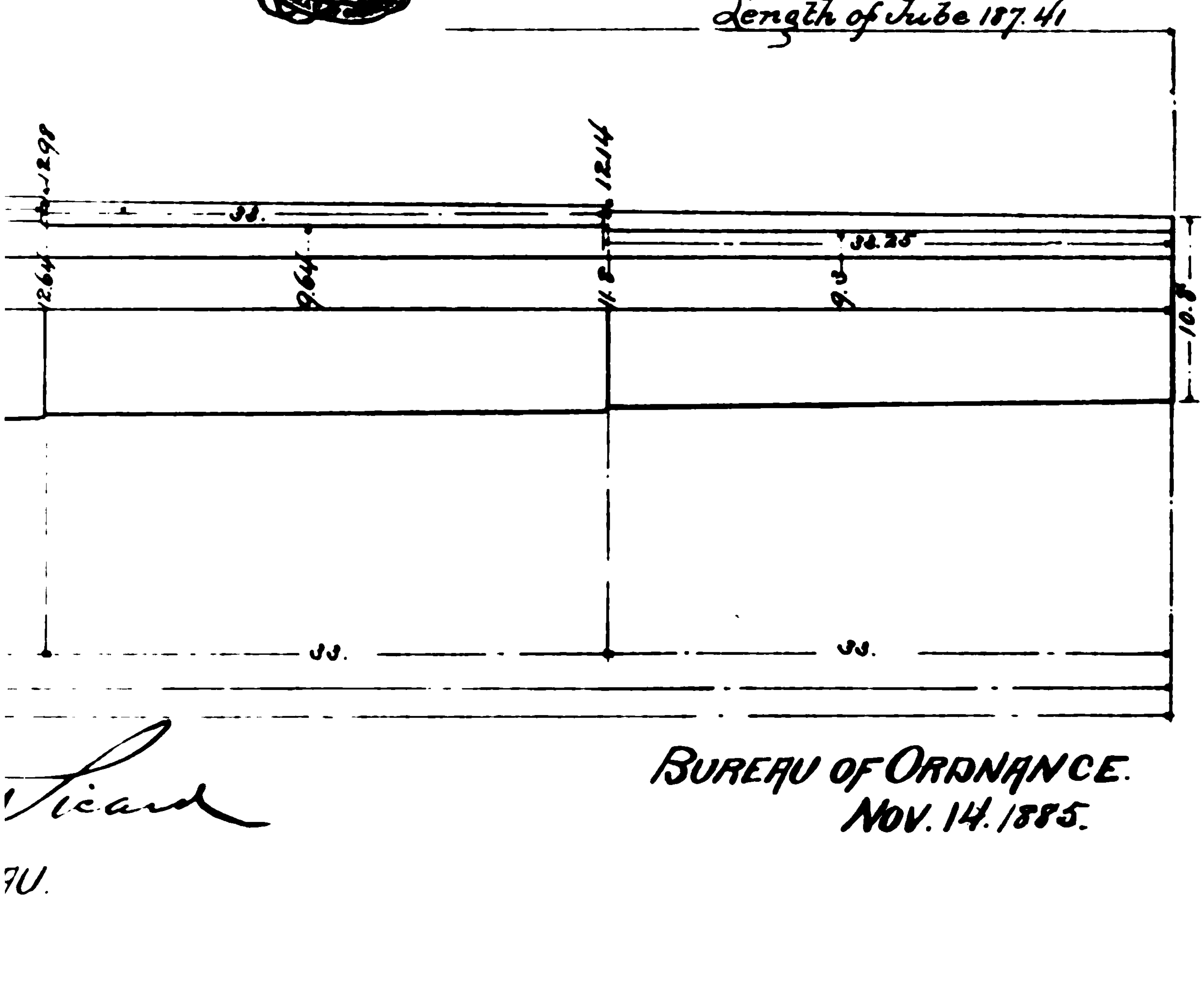
2 rings, star gauge.
2 spars for target frame.
1 box, iron, for boat.
1 hoisting spar.
3 calipers for interior measurements.
1 set gauges, fillet.
12 sheets iron gauges, fillet.
350 copper cylinders for crusher-gauge.
850 cylinders for crusher gauge.
1 box, packing, torpedo fuse.
1 water-cooler stand.
143 hooks, fire bucket.
195 hooks, magazine screen.
117 hooks, powder chute.
320 hooks, port lanyard.
8 hooks, train rope, 60-pounder.
4 hooks, copper and thimbles.
35 hooks, battle lantern.
150 hooks, rammer, and sponge.
1 table.
1 blue printing frame.
1 oil-tempering tank.
6 tin paint pots.
2 tin pans for lathes.
1 grindstone plate.
2 gun trucks.
1 joint sectional staff.
152 copper rivets.
1 cartridge box, experimental.
13 target frames.
3 locking levers for 80-pounder spring firing attachment.
2 eye bolts and shaft, 6-inch carriage.
9 beckets, battle axe.
6 shot beds.
2 bolts, 6-inch carriage.
1 reflective cylinder gauge.
1 port-sill pivot clamp.
4 bronze castings for 80-pounder elevating gear.
4 castors for table.
1 core box, 20-pounder, shell and sabot.
7 washers for 6-inch mushroom stem.
2 mushroom stems, rough, 6-inch.
12 castings, roller handspike pins.
12 castings, roller handspike.
48 castings, roller handspike coaks.
8 tool chests, armorer's.
2 sets armorer's tools.
11 sets screw-drivers and chisels, armorer's.
7 sets handles, hasps, &c., for armorer's chests.
8 sets De Bange check plates.
14 De Bange check pads.
18 bolts for securing Hotchkiss mount.
1 skeleton Hotchkiss gun and mount.
2 bronze caps for Clark's turret.
50 buttons, powder chute.
1 pattern and core box, steel shell.
6 patterns 6-inch shell.
1 pattern 8-inch tray.
1 pattern 6-inch tray.
1 pattern 3-inch cartridge bag.
2 patterns 8 inch cartridge bag.
2 patterns 30-pounder cartridge bag.
1 pattern 5-inch cartridge bag.
1 pattern, front transom, 8-inch half-turret carriage.
1 pattern 6-inch chamber gauge.
2 patterns 60-pounder burster bags.
1 pattern 60-pounder cartridge bag.
1 pattern 30-pounder burster bag.
1 set patterns tower mount and circles.
1 pattern for bronze caps for Clark's turret.

1 set patterns for cylinder, 6-inch carriage.
1 set patterns for shifting pivot and socket, 6-inch carriage.
1 set patterns for trunnion seats and caps, 8-inch barbette carriage.
1 set patterns for worm wheel, 8-inch barbette carriage.
1 pattern Hotchkiss mount and stand.
1 pattern 6-inch deck circles.
1 pattern 6-inch rammer head.
3 patterns 6-inch rear training transom.
1 set patterns, brackets and cylinders, 8-inch barbette carriage.
2 patterns 6-inch cartridge bags.
1 pattern 6-inch burster bag.
1 set patterns, bottom transom, 8-inch barbette carriage.
1 pattern 6-inch face plate.
1 pattern 6-inch bore gauge.
1 set patterns 8-inch B. L. R. S. shell.
1 pattern 20-pounder B. L. R. burster bag.
1 pattern for track of tower mount.
1 pattern for reflecting cylinder gauge.
1 pattern of ship's pendulum.
1 model 8-inch shot.
1 model 6-inch shot.
1 model of monitor turret.
1 model, wood, 5-inch.
1 model, wood, 8-inch breech mechanism.
1 template, side armor, 8-inch carriage.
1 former, 6-inch passing box.
1 set letters, &c., for marking Hotchkiss guns.
1 template for modified shield, 6-inch carriage.
1 skeleton, Atlanta's side.

Making miscellaneous patterns.
Repairs to stores on hand.
Repairs to stores for vessels fitting.
Repairs to stores for vessels in commission.
Repairs to buildings, wharves, shot-beds, gun-skids, &c
Guarding public property.

TORPEDOES.

3 batteries, boat, portable.
200 battery fittings.
12 blocks for detonators, wood.
3 sets boat fittings.
46 boxes, packing.
12 boxes for detonators, tin.
25 boxes, storage, gun-cotton magazine.
143 boxes for wet gun-cotton primers.
6 boxes, wire.
29 butts, secondary spar.
321 cans, distance.
278 cans, gun-cotton.
150 caps, fulminate.
8 caps, secondary spar.
180 caps, water.
1,000 pounds carbonic acid, liquid.
2,500 cases, fuse.
179 cases, primer.
152 cases and tripods.
7 cases and tripods for contact torpedoes.
17 cases without tripods for contact torpedo.
21 cases, torpedo.
35 connectors.
48 cots, rubber.
8 covers, canvas, for steel spars.
1,027 cylinders, gun-cotton.
99 detonators, dummy.
208 detonators, D. E.
45 detonators and splices.
6 dryers, gun-cotton.
240 pieces emery cloth.
234 flannels for galvanometer.
219 toggles.



Sicard

BUREAU OF ORDNANCE.
NOV. 14. 1885.

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profile of the tri-faced as far as possible, it is believed that the cause of the difference in performance is to be found in the difference in profile and distribution of strength, the ogival point being crushed at the instant of impact.

Respectfully, &c.,

W. M. FOLGER,
Commander, Inspector of Ordnance in charge.

Capt. MONTGOMERY SICARD, U. S. N.,
Chief of Bureau of Ordnance.

1199.]

NAVAL ORDNANCE PROVING-GROUND,
Annapolis, Md.

SIR: In compliance with your instructions of the 9th instant, I have the honor to submit the following data regarding the experimental high-power musket manufactured by the Winchester Repeating Arms Company.

The breech system is that known as the Marlin, and is of the general principle of the lever, with a block moving in a vertical plane between the cheeks of the frame.

I think this general system should be considered as an essential feature, as giving greater strength than any other of the small-arm breech mechanisms.

GENERAL DATA.

Weights.

The piece	$12\frac{2}{16}$	pounds.
The bullet	400	grains.
The charge	200	grains.

Lengths.

	Inches.
The piece	48
The barrel	32
The cartridge	4.425
The bullet	1.562

The rifling.

The ratchet system with nine grooves and lands.

	Inch.
Diameter across lands	.45
Depth of grooves	.007
Width of lands (on the flat)	.03

The twist is increasing from zero to one turn in 30 calibers.

BALLISTICAL DATA.

The ballistic results furnished thus far are from experiments in a tentative way with the view of the development of the suitable charge and band conditions.

It is not considered that the most favorable performance has yet been attained, and it is requested that this report be considered as merely preliminary.

The maximum muzzle velocity recorded is 2,030 f. s.

The maximum penetration into wrought-iron—a 1.5 inch plate—is 1.25 inches.

The maximum penetration into steel—a 1-inch plate was pierced, with a reserve of force (measured by the penetration into wood) sufficient to kill two men.

The maximum penetration into wood—1-inch boards—40 inches.

Lacking opportunity, but few expriments have been made in the particular of accuracy; enough has been developed, however, to establish the fact that the piece is defective in this respect, the results at 500 yards being slightly less favorable than those furnished with the service infantry arm, where, with the extremely flat trajectory present, they should surpass these results.

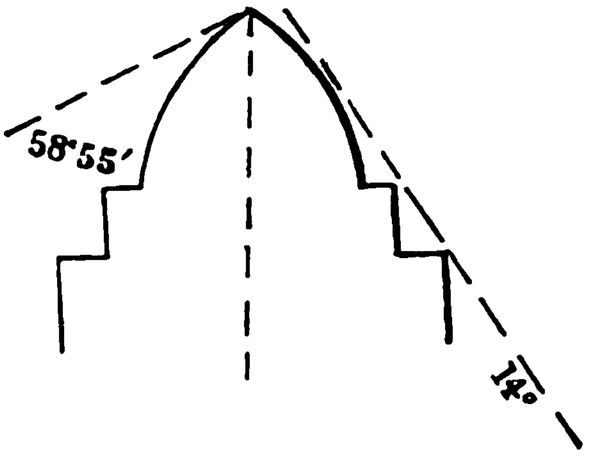
The subject has received consideration, and I have about concluded that the cause of the large mean error is to be ascribed to vibrations of the barrel.

I think the results thus far furnished are promising, and, as you have probably noted, they surpass the work done in a similar direction in Germany and England.

Should you concur in this opinion of their value, I shall have the honor, as funds become available, to recommend the manufacture of another barrel, in which the

(Round 1. Projectile 1, photograph 27.)

Angles.

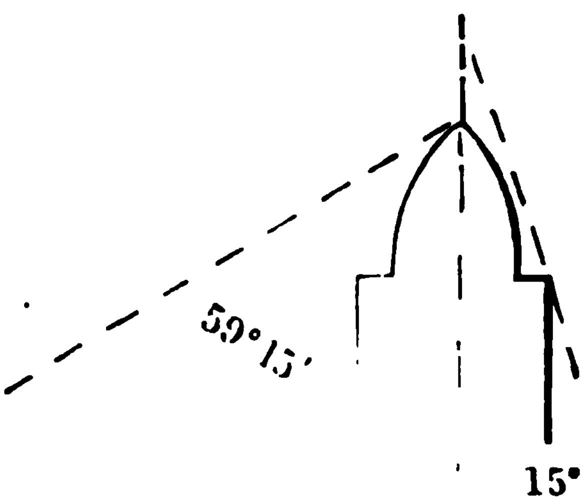


	Inches.
Length of impact	6.6
Width of impact	1.7
Maximum depth	0.375

The projectile scored out with slight damage to the target. The second step broke off (photograph 28), with indications of a flow of metal, showing that the temper was in a measure superficial. It was evident, as in the two subsequent rounds, with the stepped specimens, that the butt had swung in against the target, the rear cylinder being cracked from the base to the lower edge of the band. The projectile was otherwise uninjure dand undistorted.

(Round 2. Projectile No. 2, photograph 27.)

Angles.

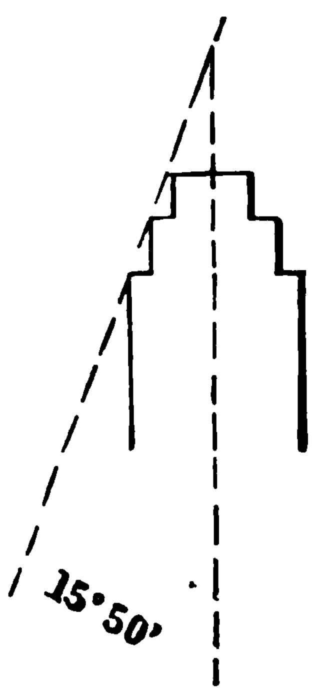


	Inches.
Length of impact	7.5
Width of impact	1.6
Maximum depth	0.25

The projectile scored out, doing slight damage to the target, and quite uninjured.

(Round 3. Projectile 3, photograph 27.)

Bearing angle of three points with axis.



	Inches.
Length of impact	7.625
Width of impact	1.85
Maximum depth	0.44

It was quite evident, considering the character of this impact, that all cutting edges bit at practically the same instant, and mutually assisted in scoring out.

The third edge was broken off, as shown in photograph 28. The rear cylinder was cracked to the lower band edge.

(Round 4. Projectile No. 4, manufactured at Naval Ordnance Proving Ground. Chrome steel.)

	Inches.
Length of impact	6.25
Width of impact	3.00
Depth of impact	1.6

The projectile bit very well, and apparently expended the greater part of its energy upon the plate, cutting the latter completely through to the backing. It has not yet been recovered, the rainy weather not permitting digging into the butt. I shall have the honor to forward a supplementary report of its condition. It is quite unlikely, judging from the character of the impact, and the fact that it was much stronger in profile than the stepped specimens, that it is in any way injured.

CONCLUSIONS.

As you will doubtless appreciate, the advantage of the single cutting edge for very low angles is definitely illustrated.

Respectfully, &c.,

W. M. FOLGER,
Commander, Inspector of Ordnance in Charge.

Capt. MONTGOMERY SICARD,
Chief of Bureau of Ordnance.

well inside the gun and replaced by the end of a cloth until the rod is insert the proper point, when the cloth is hauled off to the rear, the cap being replac the end of the exposure by withdrawing the camera far enough to reach the len with the hand.

The rod carrying the camera and reflector having been inserted to the p point and the lens uncovered, the rays from an electric light are thrown int bore, over and around the camera. Care should be taken to keep the light m to avoid danger of reproducing the shadow of the camera in the picture.

The arrangement above described could be easily made on board any ship wl lens is already supplied. The camera used at this station was made by an ord carpenter.

No plate-holder was used. The plate was inserted in grooves at the proper inside the camera through a slit, which was protected after the insertion of the by a light tight slide.

The size of camera best suited to use with a 6-inch gun is 3¼ by 4¼ inches, or dimensions, at the base. This will take a plate 3¼ by 4¼ inches, a regular comm size.

It is believed that slow plates should be used, and the kind known as Carbu is recommended.

Photographs of the slope of 6-inch No. 4, and of the erosion in the forward p the chamber of the South Boston gun after one hundred and fifty-four roun herewith forwarded in illustration of the method described.

I am, sir, your obedient servant,

W. M. FOLGER,
Commander, Inspector Ordnance in Ch

Capt. MONTGOMERY SICARD,
Chief of Bureau of Ordnance.

2448
144

NAVAL ORDNANCE PROVING-GROUND,
Annapolis,

SIR: I have the honor to submit the following summary of the work done a station during the past year:

POWDER.

The most important subject for experimental development has been the pow the armament of the new cruisers, that used in the antiquated batteries of the vessels being entirely unsuited to the new conditions of high-power guns.

The German brown prismatic or "cocoa" powder, of which a certain amou been purchased for experimental purposes, furnished favorable results in the caliber, using excessive charges. Its superiority to the United States standar experimental powders which had been previously suggested, and its almost g adoption abroad, lead to a persistent endeavor by the Bureau to reproduce its ties at the Du Pont mills. These efforts, after numerous failures, have accomp results which may be considered as definitely favorable.

A muzzle-velocity of over 2,000 feet per second with less than 15 tons ch pressure per square inch, using charges of 50 pounds, with the service projec 100 pounds, has been obtained in the 6-inch steel B. L. guns.

The development of the ballistic qualities of the 5-inch gun not being a ma immediate necessity, but a single sample of the new powder has been fired fro caliber.

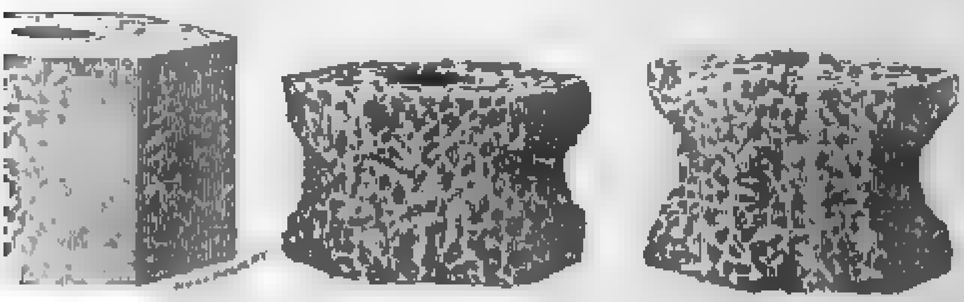
This furnished a muzzle velocity of 1,960 feet seconds with 13.7 tons pressure, a charge of 30 pounds, a the standard projectile of 60 pounds, which, consideri conditions, may be regarded as extremely favorable.

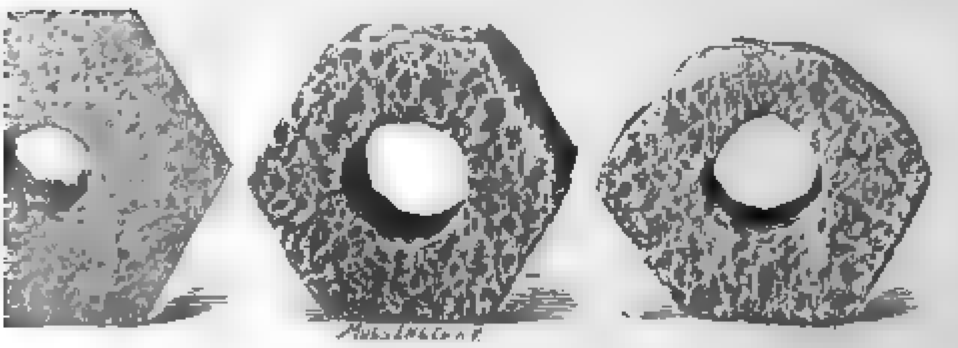
The characteristics of the grain, as regards its rate of burning, are under co control in manufacture, and there are definite grounds for belief that the ch needed for the larger calibers of guns soon to be furnished for proof will prese difficulty.

A series of experiments to develop the comparative hygrometric qualities, a rate of burning as effected by temperature, of the German and the domestic a has been in progress for some time, which thus far does not present any unfav feature in the domestic grain.

It is believed that a suitable brown prismatic powder may be developed f 8-inch converted M. L. rifle, with which its ballistic qualities would be notab proved.

are, the composition and process of manufacture are a secret and the Messrs. Du Pont. I will state, however, that the proportions of the established on sound chemical principles, which have in view the the most characteristic features of the German grain. The physical ain as affected by its density and the method of manufacture, which nfluence on the character of the combustion, resembles closely the





and 2, showing an unburned grain and two others which were blown sumed, illustrate the progressive nature of the powder. It will be ere is an increasing surface outside as well as through the central

as a portion of the proposed new armament, of the various calibers s, necessitated considerable experimental work in the development

k powder has been produced for these guns by the Du Ponts, under f the Bureau's agents.

s far reached are presented in the following table, and include all s purchased to date:

Gun	Charge.	Velocity.	Pressure.
	Grammes.	*Feet.*	*Tons.*
.G	820	1,854	12.8
G.	860	1,837	14.0
.G	470	1,728	10.4
G	500	1,706	11.9
.C	222	1,487	12.9
.C	220	1,484	13.9
C	82	1,318	10.3
C	80	1,310	7.0(?)

ave been instituted under your instructions tending to the manuantry of the Lorenz principle in small-arm cartridges of compressed ich favorable results have been obtained abroad.

mature to promise a successful development, but there would seem difficulty in obtaining as favorable showing as is claimed by the g firms

HIGH EXPLOSIVES.

the high explosives during the year has been mainly in the direction tal employment of wet gun-cotton as the bursting charges of shells. he subject of the ignition of such charges has been pursued with

such results that the adoption of the principle developed for servi a question of time.

Arrangements are being made under your instructions to explo mortar torpedoes recently received from the Washington navy-y

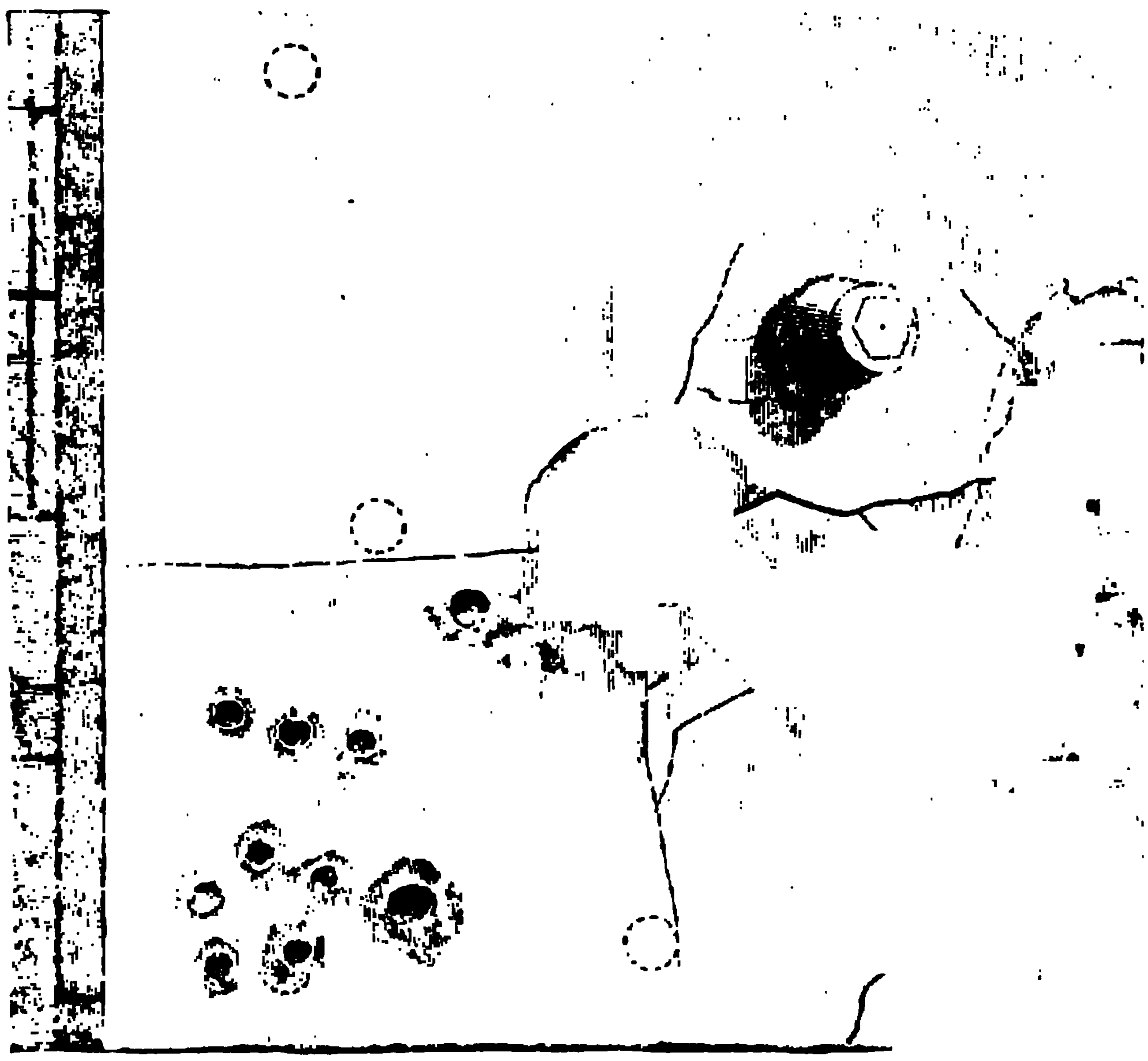
ARMOR-PIERCING PROJECTILES.

The experimental development of suitable characteristics in met and form of head has made satisfactory progress, mainly in the (in my reports of last year.

Two blunt tri-faced 6-inch projectiles tempered at this statio ruary 21 against an 8-inch Brown (English) compound plate, ba of oak. The points of each pierced the plate but were arreste Both projectiles broke up, as has, it is believed, been the invariabl of compound armor. (See $\frac{454}{26}$).

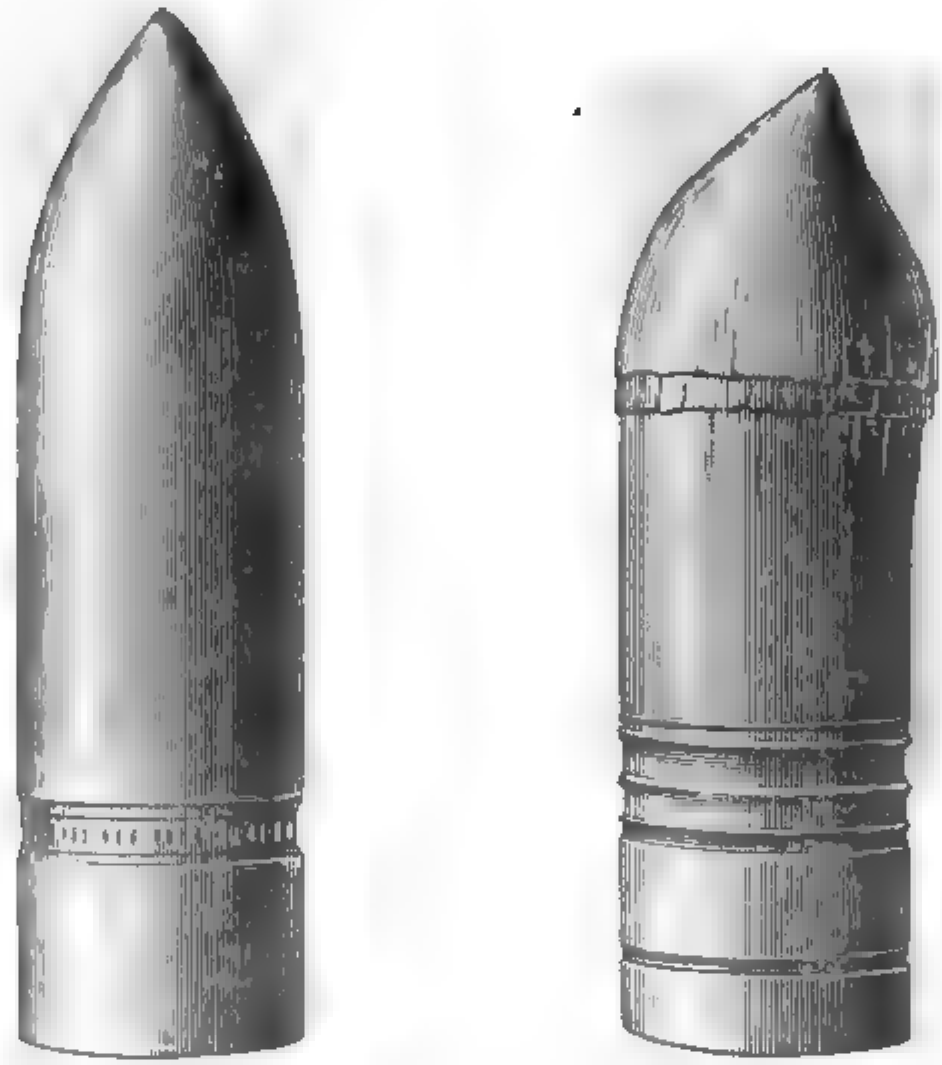
Two ogival-pointed 6-inch projectiles were fired against the sa furnishing somewhat less favorable results. (See $\frac{1807}{113}$).

A sharp tri-faced 6-inch steel projectile was, on November 25, fir Brown plate, and reached unbroken, but cracked (remaining in t penetration of 9 inches. The plate was badly shattered about the through its entire thickness to the upper edge, Photograph 9.



large number of Hotchkiss armor-piercing projectiles, of calibers 37 millimeters 57 millimeters, has been manufactured and fired against steel plates, in comparison with the standard Hotchkiss make, with results which have been uniformly favorable as regards armor-piercing qualities (fragments at explosive rupture not considered), to the naval ordnance proving ground production.

The superiority consisted mainly in the metal and temper conditions, it being found frequently possible to use an N. O. P. G. projectile three successive rounds after piercing a maximum thickness of shield, when the Hotchkiss specimen would be broken without explosive charge at the first round.



Photograph 10 is of a comparative test where the two (47 millimeters R. F.) were fired against 3 inches of steel. The N. O. P. G. projectile was quite unchanged in dimensions.

The ogival form of head is considered as more advantageous from an economical point of view in manufacture.

In accordance with your instructions, considerable study has been made of the cost of manufacture of steel ammunition.

The cost of the methods employed here are notably cheaper than Hotchkiss prices, and results of a visit to the manufacturers of similar work at the North indicate that both projectiles and cases may be made at a reduction in cost.

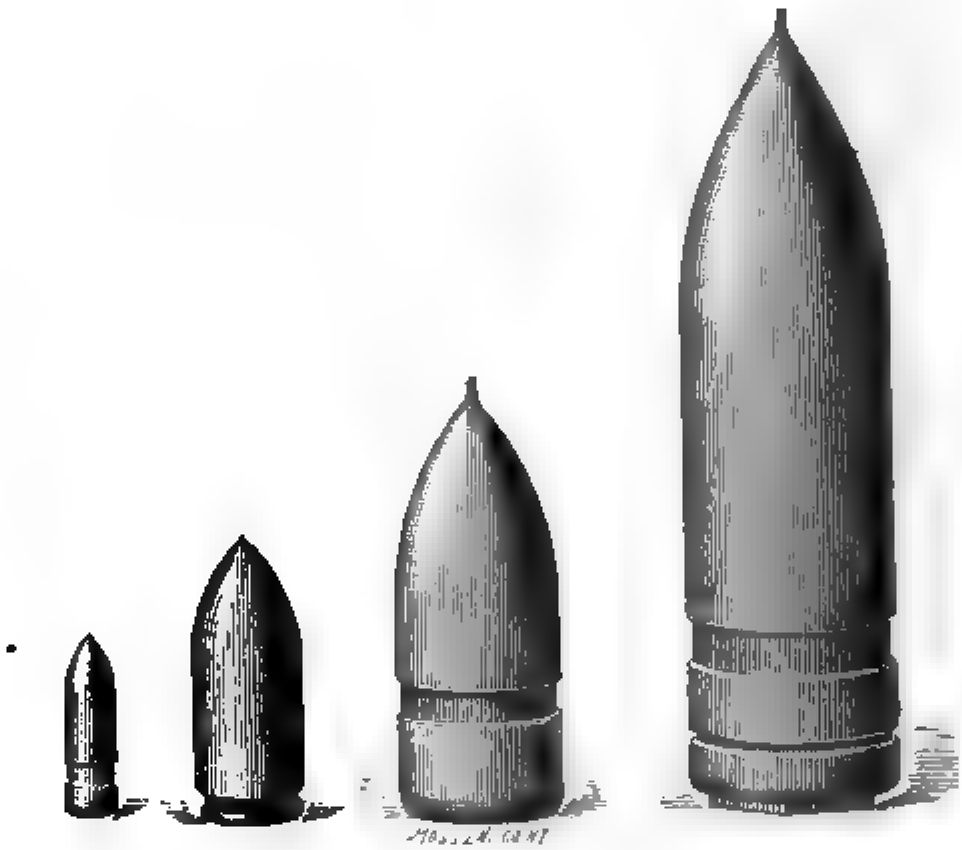
The method recently patented by Mr. George F. Simonds, of Fitchburg, Mass., of forming the projectile, of which mention has been made in special reports, furnishes features of unusual interest in this direction, and it is believed that the system will eventually be generally adopted on account of its economy and expedition in manufacture.

Photograph 11 illustrates samples of the work of the Simonds rolling-machine.

It may be mentioned, in connection with the subject of Hotchkiss ammunition, that a limited number of 57 millimeters and 47 millimeters R. F. common shell have been made at the Washington navy-yard and banded at this station for an experimental test as to the effect upon range and accuracy of the N. O. P. G. band.

Fired at 3 degrees elevation these projectiles furnished the 57 millimeters a mean range of 2,081 yards; the 47 millimeters, of 1,808.7 yards. Hotchkiss standard com-

mon shell, at the same elevation, furnished, respectively, mean ranges of 2,123 and 1,809.2 yards.



A number burst in the explosion-chamber furnished—

Caliber 47 millimeters, 81 fragments, of weights varying from .5 to 84 grammes with the 57 millimeters, 105 fragments, of weights from .5 to 181 grammes.

THE PROOF OF HIGH-POWER B. L. GUNS, RANGING, ETC.

Six 6-inch and one 5-inch guns of the standard naval types have been furnished for proof; three of the 6-inch and the 5-inch have withstood considerably more than the statutory proof of 10 rounds.

The necessity of making all of the experimental work connected with the development of the powder and the tests of carriages, of percussion-firing devices, and of projectiles with guns intended for service issue, is extremely regrettable, and Nos. 1 and 4 of the 6-inch caliber have been already subjected, the former to 275 rounds and the latter to 57 rounds.

The single 5-inch gun furnished has a record of 26 rounds. Six-inch No. 1 has been ranged at a muzzle velocity of 1,915 feet seconds, with German cocoa powder.

This work will, however, need to be repeated for the higher velocity furnished by the American powder.

The Hotchkiss 57-millimeter rapid-fire gun and the 47-millimeter and 37-millimeter revolving cannon have likewise been ranged, the former with the increasing velocity obtained with the American powder and the latter with velocities equal to those of the tables furnished by the Hotchkiss firm.

MISCELLANEOUS WORK.

The measurements of chamber-pressures in the Hotchkiss guns in the development of their powder presented some difficulty, it being inexpedient to place gauges in either the breech-blocks or chamber-walls, the guns being ultimately intended for service issue.

Assuming that the pressure on the base of the projectile was (nearly) two-thirds of that upon the bottom of the chamber, gauge-housings were manufactured of a form resembling the projectile. These, banded with the gauge in place, were made to weigh equal with the armor-piercing projectile of each caliber, care being taken to preserve the service density of charge in a proper allowance for the head of the gauge.

The housings were tempered, in order to lessen the wear consequent upon firing into the sand-butt. They were, of course, rebanded for each pressure round.

In order to verify the accuracy of the assumption as to the amount of the pressure upon the base of the projectile 6 rounds were fired from 6-inch and 5-inch B. L. guns, in which the projectiles were provided with base-gauges, the pressure upon the

I will refer again to the entire unsuitability of the position of the proving-ground for the work now in hand and in immediate prospect. The oyster industry of Annapolis keeps the range crowded with small craft during eight months of the year, and weather most suitable for my work is precisely that which the oysterman needs in his calling. The frequent cases I have had of projectiles of smaller caliber leaving the butt leads me to anticipate annoyance from this cause.

There have been complaints from Horn Point of glass being broken and plastering knocked down from violence of concussion at the discharge of the 6-inch caliber. It is unnecessary to note that these effects will be much increased in work with the larger guns.

It is urgently recommended that a more suitable position may be purchased by the Department in order that the needed experimental work and proof of guns may not be definitely interrupted.

Respectfully, &c.,

W. M. FOLGER,
Commander, Inspector of Ordnance in Charge.

Capt. MONTGOMERY SICARD,
Chief of Bureau of Ordnance.

808
42

UNITED STATES TORPEDO STATION,
Newport, R. I.

SIR: During the past two months experiments have been made with a view of deciding upon the best method of packing gun-cotton in the service torpedo.

The best authorities upon gun-cotton are agreed that the more closely the charge surrounds the primer the more efficiently the primer will act. Abel and others have shown that one disk of gun-cotton will detonate another when separated from it by a distance of one inch or less when the two are resting upon the same solid supp[...] But it has not been shown that the destructive action of a given quantity of gun-cotton depends upon the closeness with which it is packed within the limits above stated. Numerous experiments on a small scale made by different authorities have shown that the more rigid the connection between the parts of a charge of gun-cotton [...] more efficiently will the detonator act. In view of our very limited knowledge of [...] manner in which gun-cotton is detonated or the manner in which the detonation is propagated from one portion of the mass to another, I considered it desirable to [...] some comparisons between the present service torpedo and others containing the [...] quantity of gun-cotton but packed solidly about the primer. The preliminary t[...] were made on February 13 at Black Pond, about 10 miles from Newport, where [...] ice was 6 inches thick. The size of the crater is plainly marked by the circular op[en]ing, which is cleared in the ice, and by properly controlling the conditions of the experiment the size of the crater furnishes a means of comparing the forces [...]. Thus if the charges are the same in quantity, submergence, depth of water, and [thick]ness of ice the same, the only difference being in packing the gun-cotton in the torpedo, the resulting craters in two such cases will furnish a measure of the explosive force of the two torpedoes. It was found, however, that in order to secure a complete history of each explosive it was necessary to measure the height of the jet as well as the diameter of the crater. This could be best done by photographing the jet, and [...] following plan was adopted:

Two service torpedoes were prepared, and two other experimental ones, each containing the same quantity of gun-cotton as the service torpedo, but in which the [...] cotton was packed as solidly as possible in a sheet-iron case, a portion of the [...] being cut into such forms as best to fill the spaces between the whole disks. [...] same quantity of dry primer was used in each and the same kind of detonator. It was planned to fire a pair of these (one exercise and one experimental) at the same t[ime], both being submerged to the same measured depth below the surface of ice, an[d] [...] photograph the jets by the instantaneous method when they reached their maximum height. In order that the photograph might be easily measured a vertical staff 4[...] feet high was placed midway between the two torpedoes, which were 200 feet apart, all three being on the same line, which line was perpendicular to the one joining [...] staff and the position of the camera. In this manner the staff was photographed [on] the same plate with the jets, and being of a known height it served as a scale by which the heights of the jets could be measured with all necessary accuracy. Although it [was] not practicable to take the photograph at the exact time of maximum height, yet as the two jets to be compared would be equally in error the comparative efficiency [de]duced therefrom would be practically correct.

Unfortunately, in the first set of experiments above referred to, the experimen[tal] torpedo of the first pair failed to detonate, and the service torpedo failed in [...] second pair, so that the craters only could be compared. The service torpedo wh[ich] detonated produced a crater 33 feet in diameter and the experimental one a cr[ater]

diameter. The relative efficiency of the two torpedoes is fairly repre- the squares of these numbers, or they are to each other as 1089 is to 1 is to 1.13. In these experiments the ice was 10 inches thick, and the were 8 feet below the upper surface of the ice. Although there is no le or accurate means of measuring the size of the crater than by form- e where permanent record is made to be measured at leisure, yet the diffi- btaining ice over a sufficient depth of water and in a place where firing would not be objectionable decided me to rely upon the photographs for ter as well as height of jet.

l set of torpedoes were prepared, consisting of two service and two experi- es in which the disks were packed in a single sheet-iron cylinder and dged by pieces of oak carefully formed to fill the spaces between the at the whole formed a solid mass about the primer case. Two casks were 130 feet apart in 22 feet of water, and midway between them the sailing s anchored, the top of whose topmast was 45 feet from the water. When nces were all determined a pair of the torpedoes were slung to the casks center of each torpedo was 10 feet below the surface of the water. The before, was placed on a line perpendicular to the line joining the torpe- bout 220 feet from each of them. The two were connected in series with ne and fired together and photographed as near the maximum height as

nd pair were placed, fired, and photographed. In this case the height of 's mast, 45 feet, which was photographed in each case, served as a scale to measure the crater and heights of jet.

ese photographs were measured and the efficiency of the torpedoes com- n the first case above mentioned, it was found that the efficiency of the pedo was to the efficiency of the experimental one, in the first case, as 1 nd in the second as 1 is to 1.22; an agreement which my experience did e to expect. The superiority of these last over the first experimental tor- robably due to the fact that the last were much more solidly packed than interspaces were filled with pieces of gun-cotton. Although such a limited experiments cannot be considered conclusive in such a matter, yet when nnection with the allied experiments of Berthelot and others it appears ficiency of the service torpedo would be increased by packing the gun-cot- losely about the primer. This whole matter has been submitted to the we recommend that the gun-cotton be hereafter pressed in cubical masses cylinders. This would make it possible to pack a charge in a solid mass er quantity in the same space now occupied by the service torpedo, or the tity in a smaller space and secure a more efficient torpedo.

advantage which would probably result from such a change would be a re- the size of the dry primer required. This question is now under investiga- changes recommended would not only make the torpedo more compact cheapen its manufacture. If the Bureau should approve of this change, I t a drawing of the torpedo-case to be used. It would involve a change in g and pressing machines, but the expense would not be great. Informa- ail on this point also will be furnished if the Bureau approves what is here

It was thought better to press the gun-cotton into cubical masses of same weight as the present disks, rather than 10-inch cylinders, the full rpedo, which would be an awkward size to handle, and necessitate at least forms to make the torpedo complete. A cubical mass 2.9 inches each side ction and 2 inches high would be adapted to all uses. The present disks cubic inches, those proposed would contain 17.

eriments above referred to were carried out by Lieutenant-Commander sisted by the class and by Mr. Angstrom, who took the photographs.

ectfully, your obedient servant,

W. T. SAMPSON,

Commander and Inspector of Ordnance, in charge of station.

NTGOMERY SICARD, U. S. N.,

Chief of Bureau of Ordnance.

[Indorsed.]

l torpedo has been made and experimented with to determine whether the onstruction had the necessary strength, &c. It was subjected to several the fastest steam launch, finishing by running into the breakwater with submerged. The secondary spar was bent through an angle of 45°, but was not injured. Experiments have since been made in comparing the round and the square torpedo upon the steering of the boat. No differ- e detected.

I send to-day drawings of the cubical torpedo for the Bureau's approval. T and necessary attachments for the spar are to be made of malleable iron or mit the case to be tinned inside and outside. The gun-cotton is introduced thro opening for the primer case, the primer case being afterwards soldered in plac The attachment for the spar is cast in two pieces, one being left upon the t when packed and stored as a handle by which it may be lifted and moved ab

It is proposed to make a contact-firing arrangement which may be attached torpedo, thus making it possible to use all the torpedoes as service torpedoes or tact torpedoes. The contact arrangement is very similar in detail to the one use except that it is all inclosed in a small metal box which is attached to the of the torpedo case by four screws.

A drawing of the torpedo with the contact attachment will be sent to the I

In accordance with the Bureau's suggestion contained in first indorseme Station letter of April 3, 1885, round torpedo cases are now being made u same principle as the above described, in which the gun-cotton disks (round) packed without using the tin cylinders. These cases to be used only until tl ent supply of round disks is exhausted.

W. T. SAMPSO
Commander and Inspector of Ordnance, in cl

812
40

UNITED STATES TORPEDO STATIO
Newport,

SIR: I have the honor to transmit herewith the report of a Board upon boat for the spar torpedo. This question early engaged my attention, because the spar had not proved satisfactory to the Bureau. It was only after I had de my own mind what ought to be the character of the spar that I appointed th to work out the question afresh and develop the details. There is hardly o to add to the report of the Board, but I might say that the proposed fittin probably cost about the same as the present one. The spar is heavier than tl ent one, but it will stand a speed of 10 knots with a large margin of safety, w present spar will always bend with a speed of 8 knots, and using the same c tion its weight would have to be doubled to secure the strength of the propos

The proposed spar places the center of explosion only 22 feet horizontally fi bow of the boat, instead of 26. The maximum radius of the crater produc service torpedo is about 18 feet, so that the only danger to be anticipated to t is to result from her running into the crater after the explosion and receiving t ing water, and this depends upon the speed of the boat at the time of explo not materially upon the length of her spar. That no serious injury need be e is shown by the experience of torpedo boat 46, in Min River last August. Th was going at high speed when her torpedo fired, and the engines were not r until after the explosion. Notwithstanding the torpedo was placed under the of the Chinese vessel, where the column of water might be expected to be back into the boat by the form of the ship, and notwithstanding the boat ran the ship's side, she sustained no serious injury from the explosion; torpedo co 32 pounds gun-cotton. The experience of that same torpedo-boat has sugg slight change in the spar as represented in the drawings submitted. The the heel-rope should be placed in the end instead of the side of the spar, as sl Plates 9 and 10, so that by cutting the heel-rope the spar can slide through ports overboard. The French torpedo-boat, after firing her torpedo, had h spar foul the screw of the Chinese vessel so that she could not escape; if the s been fitted to slip overboard after its work was done the boat would have without a shot being fired at her.

It is thought that with the mechanical advantage possessed by the proposed in handling the spar, that one man would be sufficient for each torpedo, a should be decided that it was not prudent that a torpedo boat should be goi high a speed just before reaching her target, the whole fitting can be mad lighter than the present one and stronger. Considering the facility with wh torpedo can be run in or out, submerged or raised, when the boat is going speed, I do not think it necessary to submerge the torpedo until the momen the enemy is reached. I may add that I had a specimen piece 10 feet long of spar constructed for the purpose of testing it; for it was well known that the periments of the English with built-up spars were failures. The piece of sp structed represented the outer end of the proposed spar. It was fitted w usual secondary spar and a service torpedo fired from it at a depth of 10 fe feet of water. When the spar was carefully examined with hammer and c was found that four of the rivet-heads were broken off at different points al spar, but none within a foot of the end next the torpedo. This result was pa

The officers attached to the station since that time have been—

Commander T. F. Jewell, assistant inspector of ordnance and instructor in electricity.

Lieut. Commander G. A. Converse (reported January 12), assistant inspector of ordnance and instructor in high-speed engines and diving.

Lieut. Commander J. S. Newell, assistant inspector of ordnance and instructor in torpedoes.

Lieut. Commander W. Maynard, assistant inspector of ordnance and assistant instructor in electricity and fuses.

Lieut. Commander G. A. Totten (reported June 4), assistant inspector of ordnance and assistant instructor in torpedoes.

Lieut. Karl Rohrer (reported September 16), assistant inspector of ordnance, in charge of gun-cotton laboratory.

Surgeon J. G. Ayers (reported April 9).

Past Assistant Paymaster F. H. Clark (reported February 17).

Assistant Paymaster J. Q. Lovell (reported July 24).

Gunner J. R. Grainger, in charge of magazine and storehouse.

Mr. J. Flemiug White, chemist and instructor in chemistry and explosives.

Mr. Arendt Angstrom, in charge of drafting room and machine shop.

The force and resources of the station have been employed, as in former years, in the twofold duty of manufacturing and developing torpedoes and torpedo material for the service, and in instructing officers in the theory and use of torpedoes and the principles of torpedo attack. A class of seamen has also been instructed in the same subjects as far as its members are prepared to receive such instruction.

GUN-COTTON.

The gun-cotton factory has been running about ten months of the year, although at only one-half its capacity. Since the factory was started, in March, 1884, 17,! pounds of gun-cotton have been manufactured.

	Pounds.
During the same time there has been used for purposes of instruction.......	1,6
For experimental purposes	
For torpedo outfits for three ships....................................	2,
For Naval Proving Ground and Artillery School	1,
Leaving on hand...	11,
There was purchased in England 2,500 pounds, of which there has been used for the outfits of two vessels	1,
The remainder was issued to the Greely Relief Expedition, and afterwards there was returned by the expedition to the station.........................	*2,806
Of which there has been used for purposes of instruction, in addition to the quantity above named	1,
Leaving on hand of the English gun-cotton................................	1,

which will be used for instruction.

The processes of manufacture remain substantially the same as a year ago, except that the density of gun-cotton has been increased, experiments showing that the explosive energy increases with the density.

It has been found difficult to prevent the manufactured gun-cotton from molding. It is hoped, however, that past experience in packing may lead to such improvements as will prevent the development of this growth, which slowly destroys the gun-cotton.

Two capacious magazines have been constructed on Rose Island for the storage of the gun-cotton. The small wooden structures which had been previously used were found to become too warm during the summer months. Two of the large cases of the uncompleted fort have been fitted up for this purpose. Each is capable of taining 100 tons of explosive, or more than will ever be in store, but it was co ered advisable to have a separate magazine for gun-cotton that had developed mold and thus prevent, if possible, its extension to the other gun-cotton.

Extended investigations have been made and reported to the Bureau concerning method of drying gun-cotton and the best method of packing it in the torpedo-c and these investigations have led to the adoption of changes in previous practice in these matters.

TORPEDO OUTFITS FOR SHIPS.

New boat-fittings for torpedoes are being made for trial with the expectation of diminishing the number of men required to properly handle the boat and torpedoes in

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* Part of the gun-cotton for expedition was sent directly to New York, and was not taken up on the books here until the expedition returned.

s also been recommended that the torpedo be so far modified in form as xplosive in a compact mass and to somewhat increase the quantity em- o make the contact circuit-closing arrangement attachable to any tor- s render it possible to use all torpedoes either as contact or service tor-

f firing has been changed, by the Bureau's authority, to a voltaic bat- f the heavier dynamo machine.

PLANT.

ery, tools, &c., used in the manufacture of torpedoes and their explo- good condition and will be quite satisfactory after certain changes, mended to the Bureau, have been made. The two boilers, however, are long use. The Bureau has authorized new ones, but no satisfactory onstruction has been received.

gs are all in good condition, but an enlargement of the electrical labor- parate building for the manufacture of fuses will be recommended.

INSTRUMENTS, ETC.

al, chemical, and other instruments employed, both in investigations n, are in good condition.

past year the electrical apparatus has been increased by the addition of s galvanometers, by Elliott Brothers; one Edelman galvanometer, with to adapt it to magnetic measurements; one Hartman galvanometer; lescope with glass and wood scales; one Kohlrausch rheometer. Only is to the instruments will be required in the near future, but the build ld be enlarged, as is elsewhere recommended.

TRIANA AND BOATS

en made under the special care of Lieutenant-Commander Converse he year been thoroughly overhauled. The hull of Triana inside below has been carefully cleaned in every part and painted. The engines en apart, valves reground, steam joints renewed, &c. The deck has and the deck and upper works painted. The vessel, machinery, and y in good condition, except where a few rivets in the hull have been explosion of torpedoes.

am launches also used for purposes of instruction were placed in thor- fore the summer course commenced, and although much shaken by the osions, will be again put in good repair. These boats, however, are ow and noisy for use as torpedo boats; others are recommended.

THE LIBRARY

nged and partially catalogued by Lieutenant-Commander Maynard, his other duties. It has been increased by 134 volumes and 8 pam- s number 4 are on the subject of explosives, 18 upon electricity, 17 upon upon physics and engineering, 79 upon miscellaneous subjects. The iodicals has been increased to 34, all relating more or less directly to e station. It is confidently believed that in no other way will the serv- large a return for a moderate outlay as in well-selected books and pe- ng upon this professional work. The library now contains 1,187 vol- g the year 127 volumes have been bound. A card catalogue has been d now numbers 1,400 cards.

SUMMER COURSE.

e following officers reported for instruction in torpedoes:

s.—Capt. Byron Wilson; Commanders Silas Casey and George W. Hay-

ction.—Lieut. Commanders George W. Pigman, C. H. Rockwell, George onis Kingsley; Lieuts. J. M. Miller, F. H. Delano, A. B. Speyers, J. J. C. A. Foster; Lieuts (junior grade) John O. Nicholson and John A. signs Henry Minett, W. A. Gill, J. B. Cahoon, S. D. Greene, and J. B. t Lieut. G. F. Elliott, U. S. M. C.; Second Lieut. F. E. Sutton, U. S. s R. H. Cross, T. B. Watkins, George Fouse, James Hayes, and C. B.

In carrying out the views of the Bureau, and in accordance with the accumulated experience of the station, the course for the past summer was modified by making it consist of more practical work than formerly, and by reducing the study of theoretical chemistry and electricity, at the same time furnishing the class with printed copies of such lectures as were necessary in addition to the text-books used, and dispensing altogether with the copying which had proved so tiresome to previous classes. These changes, here roughly outlined, have proved to be a decided improvement, as was anticipated, and it is recommended that they be continued.

The ground covered by the summer course was much the same as in the past years, with the changes noted.

These changes have rendered it possible to give more time to the work of placing mines, in creeping and countermining, and in the use of search lights against torpedo boats. Our experience upon the last named subject has suggested one or two practical points which may be stated here.

(1) Search lights, to be most effective, must be mounted near the water-line in order that the beam may be nearly parallel to the surface of the water. A difference of 8 feet in the height of the light was found to make a marked difference in its efficiency.

(2) Search lights will be of comparatively little use when there is even moderate motion on the ship.

(3) To furnish protection against torpedo boats, the number of lights should at least equal the number of boats making the attack, and even when this is the case the chances are still greatly in favor of the attack.

The facilities for giving instruction in this course are good with a few exceptions, which should be remedied as soon as possible. The principal of these defects is the want of suitable torpedo boats for carrying the spar torpedo, and an opportunity to practice in the attack and defense of a vessel protected by the best modern appliances.

ADVANCED COURSE.

During the last year, from September until May, the class consisted of four members. This year there are five. As this course is intended to impart a thorough knowledge of the subjects taught, I would like to see carried out the recommendation made to the Bureau in a special report concerning the selection of the members for this course.

In both courses the officers have shown commendable zeal in availing themselves of the opportunities for acquiring information.

The plan of combining the commissioned and warrant officers in one class during the summer has worked well. The gunners did not receive instruction in high-speed engines, as it was not considered that they had the necessary preparation for such instruction nor was the knowledge likely to be required in their professional duties. This plan of associating the officers should be continued.

CONTINUOUS-SERVICE CERTIFICATE MEN.

Commencing on the 15th of June last, there has been received from time to time a selected class of seamen for instruction in torpedo work. The number has now reached twelve. The after-berth deck on board the Triana has been fitted for their accommodation. During the summer they participated in all of the work of the class of officers, and with them received special instruction in diving. They have all been down in the armor several times. Those who have joined since the course was finished have been instructed by those who had the advantage of a professional diver. It is intended to make this instruction continuous under the direction of Lieutenant-Commander Converse, so that it will not again be necessary to employ a professional diver to instruct.

During the summer six officers were down in the armor, some of them several times, and in four fathoms of water.

The continuous-service men are now assigned to different duties in connection with the manufacture of explosives, the manufacture and care of torpedoes and fittings, in experimental work with explosives, in the museum and the electrical laboratory. At each of these stations they remain one month receiving special instruction from the officers in charge of the department; at the end of the month the stations are changed, each man filling all the positions in turn. The men have shown themselves intelligent, obedient, and anxious to learn.

RECOMMENDATIONS.

I respectfully submit the following recommendations covering some of the more urgent needs of the station and service in connection with torpedoes:

(1) That there be purchased for the station two steam-launches specially made for carrying spar torpedoes. They should be built of steel not more than 45 feet long,

capable of carrying the service fittings for two torpedoes and a small steel shield not to weigh more than 350 pounds. They should have compound condensing engines capable of giving a speed of 15 knots. The success of a torpedo attack will in the future depend so much upon the speed of the boat that it is necessary to give officers an approximate idea of the conditions that will prevail in time of war. They should become accustomed to handling boats at high speed. This necessity is recognized and acted upon by every nation in the world except our own. This leads to my second recommendation.

(2) That every ship in the service, of 2,000 tons or more of displacement, be fitted with such a torpedo-boat as described above. It is folly to supply our ships with torpedoes to be used in such boats as are at present supplied to the service. Their lack of speed and noise of escaping would insure their destruction by a moderately watchful enemy. This appears such an urgent need that I hope the Bureau will strongly advocate the construction of at least fifty of these boats. There would be no difficulty in building them in this country; and they would form a powerful auxiliary in the defense of our coast.

(3) As the Bureau has repeatedly recommended the purchase of the Whitehead torpedo, it is only with a view of placing my opinion upon record upon the subject that I now recommend the purchase of at least ten first-class boats. These boats cannot now be built in this country, but there are builders who might succeed in securing in such small vessels a speed exceeding 20 knots if they had boats from the best English builders to guide them in the work. A prudent preparation for the future would require a large number of these boats. Both these last two recommendations may be considered as falling outside of my jurisdiction, but as they appear to me so important, I may be excused for making them.

(4) That a complete electric-light plant be purchased for the station. This is urged for several reasons; first, because it will soon become necessary to renew the lighting apparatus and it would be quite in the line of economy to light the island by electricity; second, the management of electric light circuits is one of the subjects that the Department expects to be taught at this station, and with a suitable plant such instruction can be given; without it it is not practicable. Our new ships are to be lighted in this way, and officers should be prepared to take proper care of them.

(5) That the Electrical Laboratory be increased so that proper use can be made of the instruments. The laboratory is a one-story building containing 977 square feet of floor surface, of which 665 square feet is occupied by the lecture and recitation room, leaving only 312 square feet for mounting the instruments. This is entirely inadequate and greatly reduces their usefulness or even renders it impossible to use them at all. The building should be increased by about 900 square feet of floor surface, which would require an addition of about 25 feet to the length of the building.

(6) That a separate small building be erected for the manufacture of fuses. The fuse-room is now in the machine-shop, and while only gunpowder fuses are manufactured it was quite safe to make them there. But since the present service detonator must be made of fulminate of mercury, a very dangerous explosive, I do not consider it prudent to carry on the work in such a valuable building as the machine-shop. For this purpose a small brick or wooden building, 20 by 20 feet, one story, would be sufficient.

(7) That a new ferry launch be purchased as early as practicable. The one now running has been in almost constant use for thirteen years, and is in many respects quite worn out.

Having been designated by the Hon. Secretary of the Navy on January 23, 1885, to represent the interests of the Navy Department in connection with the building of a sewer by the city of Newport through or across the breakwater at Goat Island, I have the honor to report that I have had several conferences with Colonel Elliott, Corps of Engineers, U. S. A., in reference to the matter. As indicated in the correspondence between Colonel Elliott and Mayor Franklin, of Newport, it was the intention to carry the main sewer of the city across the inner harbor of Newport, which was authorized by act of Congress approved December 20, 1884, through the breakwater and to terminate in 7 feet of water at a point 300 feet from the breakwater, the top of the sewer being only 1 foot under water at this point at mean low water, and consequently above water at low tides. The tracing of a portion of the harbor sent herewith shows the proposed direction and outfall of the sewer. As the effect upon the healthfulness of this island due to discharging the sewerage at this point depends upon the direction in which the currents carry the sewage, a series of observations were made extending over a considerable time to decide this question. A spar was anchored at the proposed outfall, and to it was attached a light cod-line 250 feet long, having floats at intervals. The direction and distance of these floats from the spar were plotted every hour.

The result of these observations was to establish the fact that during over 50 per cent. of the time the floats were driven in the direction of the island, thus showing that any floating refuse from the sewer would probably be deposited upon the west-

ern shore of this island. It would therefore appear desirable to carry the sewer out to deeper water and beyond the eddies which prevail at the proposed outfall. No action in the matter is demanded at present, because the city, at a recent election, declined to support a plan for raising the necessary funds to proceed with the work. As the matter now stands no steps will be taken by the city to construct the sewer until money is voted for the purpose.

Very respectfully submitted.

W. T. SAMPSON,
Commander and Inspector, in charge of Station.

Capt. MONTGOMERY SICARD, U. S. N.,
Chief of Bureau of Ordnance.

2256. UNITED STATES TORPEDO STATION,
Newport, R. I.

SIR: In obedience to the Department's order of August 19, the Board appointed to witness the examination of the class of officers under instruction in the use and manufacture of torpedoes at Newport, R. I., have the honor to submit the following report:

The examination extended over two days and part of a third. It was conducted in writing, and practical experiments in illustration were successfully made.

The Board was pleased to find that the recommendation of the Board of last year as to a change in the manner of instruction had been carried out.

The practice of writing copious notes from oral lectures, and smooth copies of the same, has been discontinued and printed lectures largely substituted, while the subject-matter taught has been much more practical; a beneficial result largely arising from the regular meetings of the inspector in charge and the instructors to discuss and decide all important points in connection with the course.

The Board is decidedly of opinion that the present course for the summer term is a great improvement over any that has preceded it, and that with such minor changes from time to time as experience may suggest there is little that remains open to criticism.

The present class consists of twenty-seven members, which number could very profitably be reduced to fifteen, as it has been the experience this summer that the number falling to the share of each instructor is too unwieldy for individual instruction, which is absolutely necessary in many cases.

Only four officers of the present class will be retained for advanced instruction, and it is believed by the Board that the above number could be increased to advantage to the service at large. Those officers showing the greatest proficiency in the usual course should be selected for the advanced course, and the Board is of opinion that it would be an incentive to those officers who have taken the advanced course to have their names designated in some way in the Navy Register.

The results of the experiments of all kinds impressed the Board not only with ability of the instructors and the zeal of the class, but with the unfortunate lack . the requisite plant for thorough practical instruction.

In the practice with search lights in discovering attacking launches as witnes by the Board, the efficiency of the lights in the hands of skilled operators was evident, but the results from an instructive point of view as regards actual w unsatisfactory, as not one of the three attacking launches was the equal o. torpedo-boat, and the two search lights could not do themselves justice si engine and governor is designed for 45 pounds of steam in the cylinder, and only 40 to 45 pounds could be obtained in the Triana's boiler, which is some distance a

The Board is of opinion that a more perfect torpedo plant should be furnished maintained, especially in regard to torpedo launches of the latest type and a gr number of pulling boats.

If more material could be obtained and a larger force employed, the el nt of would in a measure be overcome, which is a very important item, co. necessary briefness of the summer course.

In connection with additional torpedo plant, the Board would also recommend incandescent lighting plant for the torpedo station, such as would be fitted in a m— of-war, since instruction in its care and use has become an essential portion of an cer's education, and the plant will come under the care of officers on board ship have charge of the electric outfit.

There has been no practical work undertaken in defending a v t an at tack from torpedo boats and torpedoes, except by the use of sear re no means or facilities afforded at the station for this purpose, a d be remedied.

An important point of instruction during the summer was with reference to operating against submarine mines and obstructions, and although little was done in this particular, owing to the want of proper means, still enough was accomplished to show the importance of having a knowledge in this respect, and to call the attention of the class to the great importance of the subject.

In conclusion, the Board would respectfully state that although a written examination possesses advantages over an oral one for the satisfaction of instructors or a permanent board of experts, still for a temporary Board, such as we represent, the mere passing of such an examination is not entirely satisfactory. We are of opinion that it would be advantageous to have a short oral examination of the class by the instructors in the presence of the Board, either in place of or in addition to the written. While the schedule of instruction now pursued is eminently practical and satisfactory, and the officers under instructions seem pleased with it, a fair idea of the proficiency of the different members of the class can only be obtained by a careful study of the examination papers; these papers are necessarily quite voluminous, and as in addition the officers are detached on the day on which they have finished writing their last papers, any opportunity of conversation with them after their papers are examined is impossible.

We have the honor to be, very respectfully, your obedient servants,

L. A. KIMBERLY,
Commodore, U. S. N., President of the Board.
O. A. BATCHELLER,
Commander, U. S. N., Member.
F. M. BARBER,
Lieutenant-Commander, U. S. N., Member.

Capt. MONTGOMERY SICARD, U. S. N.,
Chief of Bureau of Ordnance, Navy Department, Washington, D. C.

NO. 13.—BUREAU OF CONSTRUCTION AND REPAIR.

NAVY DEPARTMENT,
BUREAU OF CONSTRUCTION AND REPAIR,
Washington, D. C., October 15, 1885.

SIR: In obedience to the Department's instructions of the 1st of August, 1885, I have the honor to submit my annual report for the fiscal year ended June 30, 1885, showing the work performed and the amounts expended, together with estimates of the amounts required for the purposes of this Bureau for the fiscal year ending June 30, 1887.

The estimates for the expenses of this Bureau, as given in the statement marked A, are in accordance with existing laws. The recommendations on this statement for increase of the salaries of the chief clerk of the Bureau, the draftsman, the assistant draftsman, and the assistant messenger are respectfully submitted to your favorable consideration.

The chief clerk, under the law, acts as chief of the Bureau in the absence of that officer, and must be competent to take charge of the Bureau. His duties are arduous, and fully deserve the salary herein estimated (viz, $2,250), which is the same as that paid to chief clerks in other Departments who are authorized to act in the absence of their chiefs.

The draftsman has charge of the drawing-room; and, as his duties and responsibilities are certainly much greater and of more importance than those of the draftsman of the Bureau of Steam Engineering, who is paid $2,250 per annum, this increase is submitted as just and proper in the case.

The assistant draftsman receives a smaller salary than is paid to per diem draftsmen in the navy-yards, while his duties are about the same. An increase of his salary is also submitted.

It is also recommended that the assistant messenger of the Bureau be restored to his former rank of messenger, with the pay thereof. He is an intelligent and capable man, and his long service in the Bureau makes him valuable.

The recommendation for three additional draftsmen is also submitted. This Bureau is now allowed but two draftsmen. In order to carry on the work of designing new ships, it is absolutely and indispensably necessary that the additional force asked for be allowed.

The estimate for the pay of clerks and writers at the several navy-yards, in statement marked E, is for services which are indispensable for the proper and systematic prosecution of the work which is to be done at the yards by this Bureau. Each and every clerk and writer has specific duties to perform, which are not affected by the quantity of work doing at the yard. The same number of blanks are to be filled, and the same number of reports have to be made and sent to the Bureau for its information, without regard to the quantity of work on hand.

estimate marked B is for the general repair of vessels at navy- ınd on foreign stations, purchase of stores, materials, machinery, of patented articles, and tools of all kinds; preservation of ma- and stores, and for the general care and protection of the navy .ine of construction and repair.

ıppropriation for last year, under this estimate, was much too ɔ permit of carrying on the repairs of vessels at home and abroad, rchasing the necessary materials, during the entire fiscal year; ·rk which was in progress was, consequently, almost entirely sus- , from time to time, for want of the necessary funds to complete is more than probable that the same difficulty will occur this

› the abolition, a few years since, of the custom of procuring our s by annual schedules, for want of sufficient appropriation, the .as become so much reduced, from lack of funds to replenish it, arly all the materials now required for work have to be purchased cific objects. The revival of the system of annual schedules obviate this difficulty; it would induce greater competition in ing the annual supplies, and would give lumber materials an op- ity to become thoroughly seasoned before being used. For this e, and in view of the large amount of work which will doubtless ɔ be done in the navy yards, the Bureau has asked for an in- l appropriation, the amount asked for being none too large for the ıent of the desired object.

estimate marked C is for completing the four double-turreted rs, Puritan, Terror, Monadnock, and Amphitrite. The amount d for this purpose is $2,923,656, divided as follows:

	$955,342
	627,288
ite	639,584
ɔck	701,442
	2,923,656

estimate marked D is for "Increase of the Navy," and asks for 000 for building the hulls of new steel vessels, and $150,000 for ools required in navy yards for building iron and steel vessels.

recommended that the new steel vessels contemplated under ıad consist of one of 2,000 tons, one of 2,400 tons, one of 3,600 ne of 5,000 tons, one of 7,500 tons, and two of 800 tons displace-

7,500-ton ship should be a sea-going armored vessel of the fol- general dimensions, &c.:

between perpendiculars	feet..	320
, extreme	do...	64
aught	do...	24
ɔment in sea water	tons..	7,500

ship should be designed with a covered gun deck.

main battery should be equal to four 10-inch and six 6-inch breech- ɡ rifles. If this battery is agreed upon, the 10-inch guns should ınted on the spar deck *en barbette* one on center line of ship d to have direct-ahead fire to 50 degrees abaft the beam on either ɔne on center line of ship aft, with direct-astern fire to 50 degrees d of beam on either side, and one on either broadside, with an 180 degrees fire; thus having three 10-inch guns direct ahead, ɪstern, and on broadside. The barbettes for all 10-inch guns to be f armor plates not less than 8 inches in thickness.

On the main or gun deck should be mounted the eight 6-inch guns, two so arranged as to have a direct-ahead and broadside fire, two a direct-astern and broadside fire, and the remainder mounted in broadside; all to be mounted on central pivot carriages, supporting segmental steel shields, not less than 3 inches in thickness.

The secondary battery should consist of fourteen Hotchkiss cannon and the necessary number of boat guns, and a full complement of torpedoes, to discharge both above and below water line.

The vessel should be built of steel, with bronze stem and stern post, and the bottom sheathed with yellow pine and coppered, as I deem this a matter of vital importance, in order that the vessel's bottom may be kept clean for a much greater length of time, obviating the necessity for going into dock to clean and paint the same so frequently, and the speed of the vessel not be impaired by fouling at a time when speed might be of the utmost importance.

The bow should be of a modified ram-shape, and possess sufficient strength that the vessel might be used as a ram. A double bottom should extend for the space occupied by the machinery and magazines. At the water line there will be a belt of armor not less than 10 inches in thickness and 8 feet in depth, tapered from the protective deck-line to 7 inches in thickness at the lower edge, and extending fore and aft for the length occupied by the engines, boilers, and magazines; the athwartship bulkheads at either end of belt to be 9 inches in thickness.

There will be a water-tight protective steel deck extending throughout the length of the ship, covering the engines, boilers, magazines, and steering gear, and strengthening the ram bow; this deck forward and abaft the armor belt to be in thickness 3 inches, and 2 inches over the armor belt amidships. To have a projecting main keel, also bilge keels, extending well fore and aft.

The vessel to be brig-rigged, with head booms, and to have a plain sail area of about 10,500 square feet.

The ship should have twin screws, with the latest and most improved types of engines and boilers, capable of developing 8,500 I. H. P., and with that power the vessel to have a speed on the measured mile trial at her normal draught of water of 16½ knots. Capacity of coal bunkers, 1,200 tons.

The principal dimensions of the proposed 5,000-ton ship (for a belted cruiser) should be:

Length between perpendiculars	feet..	305
Breadth, extreme	do ..	57
Mean draught	do ..	21½
Displacement in sea water, about	tons..	5,000

The ship to be designed with a covered gun-deck.

The main battery should be equal to two 10 inch and eight 6-inch breech-loading rifled guns. The two 10 inch guns should be mounted on the spar deck, one forward and one aft, protected by steel shields or otherwise, as may be thought best; one of these guns to have a fire from direct ahead to 50 degrees abaft the beam on either side; the other to have a fire from direct astern to 50 degrees forward of the beam.

On the gun-deck there will be mounted eight 6-inch guns, two having a direct-ahead and broadside fire, two direct-astern and broadside fire, and the others in broadside with a train of fire of 70 degrees forward and abaft the beam. All the guns on the gun-deck to be mounted on central pivot carriages supporting segmental steel shields not less than 3 inches in thickness. The secondary battery to consist of not more than fourteen Hotchkiss cannon and the necessary boat guns.

To be fitted to discharge a full complement of torpedoes, both above and below the water line. The vessel should be built of steel, with a bronze stem and stern-post; bottom sheathed with wood and coppered.

The bow should be of a modified ram-shape, and possess sufficient strength that the vessel may be used as a ram. A double bottom should extend throughout the space occupied by the engines, boilers, and magazines. To be protected at the water-line by a belt of armor not less than 10 inches thick amidships, with a depth of 5½ feet, extending fore and aft for the length occupied by the engines, boilers, and magazines; also to have a water-tight protective steel deck extending throughout the length of the ship covering the engines, boilers, magazines, and steering gear, and strengthening the ram-bow; forward and abaft the armor belt to be 3 inches in thickness on most exposed parts; above armor belt amidship, 2 inches. To have a projecting main keel, also bilge keels, extending well forward and aft. To have two masts for signal purposes and for mounting machine guns in the tops.

The ship should have twin screws, with the latest and most improved types of engines and boilers, capable of developing at least 8,500 I. H. P.; the vessel to have a speed on the measured mile of 17½ knots; coal capacity, 1,000 tons.

The principal dimensions of the 3,600 ton cruiser should be:

Length between perpendiculars	feet..	300
Breadth, extreme	do...	46
Mean draught	do...	18¼
Displacement in sea water about	tons..	3,600

The ship should be designed with a covered gun-deck.

The main battery should consist of two 8-inch and six 6-inch breech-loading rifled guns, the two 8-inch guns to be mounted on the spar-deck, on central pivot carriages, supporting segmental shields, or otherwise as may be decided upon; one on the center line of ship forward to have a direct-ahead fire to 50 degrees abaft beam on either side; and one on center line aft having direct-astern fire, and 50 degrees forward of beam on either side. The 6-inch guns to be mounted on the gun-deck, two to have a direct ahead and broadside fire, two a direct-astern and broadside fire, and the others in broadside with a train of 70 degrees before and abaft the beam; all to be mounted on central-pivot carriages, supporting segmental steel shields, of not less than 3 inches in thickness.

A full torpedo outfit to be provided. The secondary battery to consist of eight Hotchkiss cannon, and the necessary boat guns.

The vessel should be built of steel, with bronze stem and post, bottom sheathed with yellow pine and coppered. To have a protective steel deck the entire length of the vessel, and in thickness from 1½ to 2 inches on the most exposed parts, covering engines, boilers, magazines, and steering gear. The vessel to have a projecting main keel, also bilge keels extending well fore-and-aft.

To be fitted with two masts for signal purposes, and arranged to carry fore-and-aft sail, having an area of about 1,100 square feet, and fitted with military tops for machine guns.

The capacity of coal-bunkers to be from 600 to 750 tons.

The vessel to have twin screws, with the latest and most improved type of boilers and engines, capable of developing 7,500 I. H. P., and on normal draught of water the speed on the measured mile to be 18 knots.

The principal dimensions of the 2,400-ton cruiser should be:

Length between perpendiculars	feet..	250
Breadth, extreme	do...	42
Mean draught of water	do...	17
Displacement in sea water	tons..	2,400

The vessel to be designed with an open gun-deck, poop, and forecastle; built of steel, with bronze stem and stern post; bottom sheathed with yellow pine and coppered.

The main battery should consist of eight 6-inch and two 5-inch breech-loading rifled guns, four of the 6-inch to be mounted in sponsons, two having a direct-ahead and broadside fire, and two a direct-astern and broadside fire; the remaining 6-inch placed in broadside, having an arc of fire of 140 degrees; all mounted on central pivot carriages, supporting segmental shields, or otherwise, as may be decided upon. The two 5-inch guns to be mounted in combined sponsons and recessed ports, under forecastle deck, on central pivot carriages, having direct-ahead and broadside fire. The secondary battery to consist of eight Hotchkiss cannon, and the necessary number of boat guns. The necessary torpedo outfit will be provided. To have a protective deck over boilers, engines, and magazines. Double bottom to extend the length of the boiler and engine space. Bunker capacity about 450 tons of coal. To be bark-rigged, having a plain sail area of 14,500 square feet.

The ship to have a single screw, with engines and boilers of the la and most improved type, capable of developing 3,500 I. H. P. vessel at her normal draught on the measured mile trial to have a see of 15½ knots.

The principal dimensions of the 2,000-ton cruiser should be:

Length between perpendiculars	feet..	215
Breadth, extreme	do...	40
Mean draught	do...	16
Displacement in sea water, about	tons..	2,000

The vessel to be designed with an open gun-deck, poop, and forecastle. Built of steel, with bronze stem and stern post. Bottom sheathed with wood and coppered.

The main battery should be equal to eight 6-inch breech-loading rifle guns, four of which should be mounted on sponsons, two to fire direct ahead and in broadside, and two direct astern and in broadside, and four in broadside with a train of fire of 70 degrees before and abaft the beam; all to be mounted on central pivot carriages, supporting segmental steel shields of not less than 2 inches in thickness. Secondary battery to consist of six Hotchkiss cannon and the necessary number of boat guns.

The necessary torpedo outfit to be provided.

There will be a deflective steel deck running the entire length of the boiler, engine, and magazine space.

The double bottom will extend the length occupied by boilers and engines.

To be barque-rigged, with a plain sail area of about 10,000 square feet.

Bunker capacity, 300 tons of coal.

To have a projecting main keel, also bilge keels extending well fore and aft.

The ship to have a single screw, with boilers and engines of the latest and most modern type, capable of developing 2,300 I. H. P. The vessel to have a speed on the measured mile trial at her normal draught of water of 14 knots.

The two 800-ton ships are intended to take the places of the old wooden sailing ships in the training squadron, and should be of the following dimensions, &c.:

Length between perpendiculars	feet..	165
Breadth, extreme	do...	30
Mean draught	do...	12
Displacement in sea water	tons..	800

› be built with steel frames and beams, planked with two thick- › of yellow pine and coppered. To be barque-rigged, having a › sail area of about 7,000 square feet.

l capacity, 175 tons.

ıgines and boilers capable of developing 1,000 I. H. P., and to have ›ed of 12 knots. Single screw.

tery to consist of four 5-inch low-powered breech-loading rifle mounted in sponsons on central pivot carriages.

condary battery of such number of Hotchkiss cannon as may be ›d best to carry, and the necessary number of boat guns.

› Bureau has estimated for the necessary amount of money to ›ete the work in construction department on the double-turreted tors Puritan, Terror, Amphitrite, and Monadnock, and trusts that ›ress will appropriate the amount asked for ($2,923,656), that › vessels may be completed. The machinery of the Puritan has erected, and the dock trial had, and contracts have been made by Bureau of Steam Engineering for the erection of the machinery in Terror and Amphitrite, but the work under this Bureau remains at ›d-still.

cannot too strongly urge the completion of these vessels, in all ›cts, at an early day, as they will afford as good vessels of their as are owned by any nation, and are, in my opinion, the best of coast and harbor defense vessels in existence to-day. It will ire at least a year to obtain their side and turret armor after it is rized. It therefore seems very necessary that money for armor, r nothing more, should be appropriated at an early day, in order contracts for securing it may be made with as little delay as pos- ›. When completed we will have five splendid coast and harbor nse iron-clads. Should occasion require it, they can be sent to dis- points; their seaworthiness has been well tested in the past.

ıe old sailing sloops of war Saratoga, Jamestown, and Portsmouth ›apidly approaching such a condition that, ere long, they will require er expenditures of money for their repair than the law allows. The of these vessels would leave the service without suitable training s. To meet this emergency I respectfully recommend the construc- , at an early day, of two composite built, auxiliary steam-power, ›-rigged vessels, of fine models, 800 tons displacement, and light red, designed expressly for training boys for the naval service. amount sufficient for this purpose is included in the estimate for crease of the Navy."

ıe armor for the turrets, pilot-houses and armored stack for the ›le-turreted monitor Miantonomoh, contracted for by this Bureau, gh William H. Wallace & Co., with Messrs. John Brown & Co., of Cyclops Works, and Messrs. Charles Cammell & Co., of Sheffield, land, have all been delivered at the Brooklyn navy-yard. The of altering the decks and the internal arrangements of the vessel, ›commodate the new roller base turrets, is well in hand, and the tur- are in course of erection in the iron-plating shop of the yard.

ıe following statement will show the condition of vessels at the sev- navy-yards on the 1st of July, 1885:

NAVY-YARD, PORTSMOUTH, N. H.

alia.—Estimated cost to complete, as reported by Naval Constructor T. E. ›.

r	$23,044 98	
als	6,136 76	
		$29,181 74

The constructor states "the estimated time to complete this ship is forty-five days with such a qualified and experienced force as can be economically employed."

Boston.—Steel cruiser, estimated cost to complete furniture, stores, blocks, boats, and spars, $5,000; time, forty-seven days.

Constitution.—A sailing frigate, well housed over, and in fine condition for a receiving ship, but not in commission.

NAVY-YARD, BOSTON.

Wabash.—Receiving ship; requires to be sheathed, and the house over her to be so extended as to cover the poop-deck. A survey has been held upon her, a copy of the report of which was sent to the Department under date of June 18, 1885. Estimated cost, $11,894.20; time, two months.

NAVY-YARD, NEW YORK.

Tallapoosa.—The survey held on this vessel on November 29, 1884, estimated her repairs to cost $43,336, and there has been expended since then the sum of $22,814.46. It is estimated she can be completed in about sixty working days.

Richmond.—The survey held on this vessel, under date of October 2, 1884, estimated her repairs to cost $48,924, and the time required to complete, with as many men as can be worked to advantage, three months.

The Department authorized the repairs under date of October 21, 1884, but the work has not yet been commenced.

Essex.—A survey was held on this vessel April 14, 1885, and the Board reported that the estimated cost of the repairs was $41,731.69, and for the changes recommended $2,170. The time necessary to make the repairs, with a strong force, is estimated to be ninety working days.

Brooklyn.—This vessel can be ready for sea in three weeks; the work remaining to be done being principally to replace some of her furniture which was taken for the Pensacola, and to finish the pantry. It is estimated that $5.000 will complete it.

Nantucket.—Single-turreted monitor. This vessel is now in ordinary. Naval Constructor Mintoyne estimates that she can be put in condition for service by expending about $1,294.50. Time, two weeks.

Intrepid.—This vessel was formerly built for a torpedo vessel, and is now being converted into a gunboat. She is of iron, and will make a valuable acquisition, as a gunboat, to the naval service. She was surveyed in July, 1883, and the cost of alteration, under this Bureau, was estimated at $92,150. Up to the present time about $14,115.07 has been expended upon her in labor and materials. The delay in completing this vessel has been caused by having to give preference to more important objects of work, and in consequence of limited appropriation. She could be finished in four months and launched if found necessary to do so.

Thetis.—This vessel requires renovating, repainting, docking, painting of bottom, cleaning and varnishing furniture, repairs to boats, minor repairs to hull, spars, and blocks, calking, &c. It is estimated the work will cost about $4,000, and can be done in a short time if the vessel is wanted.

Miantonomoh.—The armor for the turrets of this vessel and the pilot-house plates have all been delivered. The alteration in the deck, to receive the after turret, is completed and the shell of the turret is being erected. The work of cutting out the deck for the forward turret is well in hand and the turret is in course of erection in the shop. The work should be completed this year.

Alarm.—Torpedo boat. Supposed to be ready for service. Now in ordinary.

Ticonderoga.—In ordinary. Condemned and recommended to be sold.

Alliance.—As the new boilers for this vessel are nearly ready at Norfolk, the Bureau recommends that she be sent there and docked, in order that the Bureau may have her surveyed. It is also recommended that the necessary repairs be made to this vessel at the Norfolk yard.

Vermont.—A wooden line-of-battle ship that has been put in condition for, and is now used as, a receiving ship. She requires some slight repairs and painting to complete her.

Catalpa.—A wooden tug, purchased during the war. This vessel has lately been surveyed, and the estimated cost for repairing her, under this Bureau, is $4,932. The Bureau deems it unwise to put on this vessel the repairs called for, believing, if it is attempted, that the 20 per cent. allowed by law will be exceeded.

NAVY-YARD, LEAGUE ISLAND.

Saint Louis.—A sailing sloop of war, housed over, and in fair condition for a receiving ship, for which purpose she is now used.

Pilgrim.—Condemned by board of survey, and her name stricken from the register. Recommended to be sold.

Nahant, Jason, and Montauk.—Single-turreted monitors. In ordinary at the yard. The estimated costs to put them in condition for service, under this Bureau, are as follows:

Name.	Cost.	Time to complete.
		Days.
Nahant	$35,806 06	60
Jason	36,113 36	60
Montauk	23,999 68	60

NAVY-YARD, WASHINGTON.

Wyandotte.—Single-turreted monitor. The estimated cost to put her in condition for service is $17,255.

Saugus.—Single-turreted monitor. The cost to put her in condition for service would probably exceed $200,000. The Bureau believes it would be injudicious to repair this vessel, and recommends that she be surveyed by the Board of Inspection, and, if condemned, that she be sold under the law of August 5, 1882.

Rescue.—An iron tug. Has been examined and found to be very unsafe for further service. This vessel should be surveyed by the Board of Inspection, under the law of August 5, 1882.

NAVY-YARD, NORFOLK.

Fortune.—An iron tug. This vessel is under repair, and the naval constructor estimates that it will require $5,501 to complete her.

Speedwell.—An iron tug. The deck of this vessel requires calking, and some repairs of a minor nature to her boat davits, &c. Estimated cost, $300.

Atlanta.—Steel cruiser. The furniture of this vessel, which was burned, will all have to be made anew. The naval constructor estimates that it will cost $7,998.27 to complete it; time, 90 days. The blocks for this vessel are estimated to cost $2,055 to complete them; time, two months.

Franklin.—Receiving ship. In fair condition for this purpose.

Mayflower.—An iron tug of the Speedwell class. She has been put in order, and is now in ordinary. The Bureau recommends that she be sent to the Washington yard, and when occasion requires she can be used for freighting or for yard purposes.

Ajax, Canonicus, Catskill, Lehigh, Mahopac, Manhattan.—Single-turreted monitors, iron hulls. These vessels are at City Point, on the James River. By the Bureau's order of the 28th of May, 1885, they were carefully examined, so far as it was possible without docking them, and the following are the estimated costs to put them in condition for service:

Name.	Cost.	Time to complete.
		Days.
Ajax	$15,710 00	35
Canonicus	19,502 00	45
Catskill	6,625 00	35
Lehigh	10,526 00	36
Mahopac	7,853 00	35
Manhattan	10,445 00	36

In order to fully ascertain all the defects in these vessels, it would be necessary to dock them and examine them inside and out. This would involve opening up the vessels inside, so that they could be scaled and examined, which would doubtless show up many defects that would largely increase the estimates already made.

NAVY-YARD, MARE ISLAND, CAL.

Adams.—The assistant naval constructor at the Mare Island yard has carefully examined into the condition of the work on this vessel, and reports that, as near as can be ascertained, she will cost for labor and material to complete $24,000, and that it will require four months to do the work.

Lackawanna.—This vessel has been surveyed, and the report is now in the Department, having been submitted for its information and action. The cost to fit this vessel for sea is estimated at $70,000, or 16 per cent. of the cost of a new ship of this class.

The Bureau does not recommend the repair of this vessel, believing that if it is attempted the cost will very much exceed the limit of the law (20 per cent.), but recommends that she be used as a receiving ship, and that the present receiving ship, the Independent, be surveyed and sold.

Camanche.—A single-turreted monitor. Iron hull. Built in 1862. In ordinary. By report of a board of survey on this vessel in 1882 it was ascertained that it would cost $3,460 to fit her for service, under this Bureau.

Cyane.—A wooden sailing sloop of war, whose name has been stricken from the register. She is now in ordinary, and ship-keepers are employed to take care of her. The Bureau recommends that she be sold under the act of August 5, 1882.

Ounalaska.—In ordinary. This vessel was seized on the Mexican coast for violation of the revenue laws, and turned over to the navy-yard.

Monadnock.—An iron double-turreted monitor, built at Vallejo. She is in an unfinished condition, and is moored alongside the wharf. No appropriation made to finish her as yet.

Independence.—An old wooden line-of-battle ship, in bad condition, and in need of extensive repairs to fit her for further use, even as a receiving ship. The Bureau recommends that she be surveyed under the act of August 5, 1882, and if condemned as she should be, that she be sold, and the Lackawanna take her place as receiving

In my opinion, it should be the policy of the Government to main one large navy-yard, combining in itself the advantages and facilities of all the others.

League Island was presented to the Government by the authori of Philadelphia, who incurred considerable expense in purchasing rights of other parties. This site was given with the understa t a navy-yard would be established; and, acting upon the idea, the [illegible] States have already expended there more than a million of dollars.

The advantages of League Island have been fully discussed heretofore, by persons well qualified to judge, and the opinions of such well known naval officers as Admiral Porter, Vice-Admiral Rowan, Chief Naval Constructor John Lenthall, Chief Engineer J. W. King have ways been in favor of locating a navy-yard at this place.

If I, on this occasion, enter more fully into details in refere e to t location than to other yards, it is because of its importance, expenditures that will be necessary in the future, and the fact of the other navy-yards are long-established institutions and no ment is needed to show their necessity.

It has long been the opinion of experienced naval officers that the country needs at some point a large establishment possessing all the requirements for building and preserving an iron or steel navy, such will be suitable for the future wants of this great nation. Wi exception of League Island, all our navy-yards on the Atlantic are deficient in a fresh-water anchorage, one of the first requir towards preserving iron or steel vessels laid up in ordinary. T besides, deficient in dock-yard accommodations, including me docking ships and constructional resources.

At the close of the war the use of League Island beca v ap-parent. The Government possessed a considerable num iron-clads, which required to be laid up in fresh water and secure ing ice. These vessels were, therefore, sent there, and remained, little, if any, deterioration until required for service.

The Government must always expect to encounter n in establishment of a navy-yard, when it may conflict the of trade; for notwithstanding the absolute ne ity stations for the protection of commerce and com

munity is generally ready to sacrifice the interests of the Government to their own particular benefit.

League Island is a very eligible situation for a navy-yard. It is contiguous to a large city where plenty of skilled labor can be procured at will, and where stores of all kinds can be obtained at short notice. It is within easy reach of the great coal and iron mines of Pennsylvania, and while the navy-yard was in course of construction access could be had to the great shops along the Delaware for such pieces of machinery as the yard could not supply. The defensible position of the island is well established, and no further outlay in that direction is required.

Since the introduction of steam vessels in war the policy in establishing navy-yards has changed, and it is considered wise to place them as far as possible from the sea. These places our own vessels would have no trouble in reaching under steam, while an enemy would be harassed at every step by guns, obstructions, submarine mines, torpedoes, &c. This is a very strong point in the selection of this site for a navy-yard, and is one in which several of our yards are deficient.

In a war like that through which we have passed a very considerable portion of an iron vessel could be procured at the ordinary private establishments, but in a war where we would have to compete with the navies of the great European powers we should be obliged to build such large and expensive structures that the work could best be performed by a properly organized Government establishment.

So rapidly has the science of building heavy iron war vessels advanced in Europe that we have been left far in the rear for want of means by which other nations have arrived at such perfection in naval architecture and ordnance. One of the greatest difficulties under which our Navy has labored is the want of a settled policy with regard to our navy-yards, and the class of vessels to be constructed.

A board of civil engineers has carefully examined this yard and procured all necessary information. An objection raised against League Island is the difficulty of building granite dry-docks there; but this difficulty is readily overcome by substituting a similar dock to the one now in use by the firm of Cramp & Sons, of Philadelphia, or the one at Erie Basin, Brooklyn, N. Y., where all the largest ocean steamers and war ships of foreign powers visiting the port of New York are docked, and have been for the past twelve years. These docks can be built at a less cost and in less time than a granite dock, and when completed have greater advantages, and, in my opinion, be better adapted for the purposes of our yards both in building and repairing ships. A dock of such design is very much needed at League Island, and no time should be lost in its commencement, as the yard without such an auxiliary loses much of its usefulness.

A great defect in laying out many of our navy-yards has been that little consideration was given to the future requirements of the Navy, and the yards have accordingly been built up just as circumstances at the moment might suggest.

In a message to Congress on the 8th of December, 1863, President Lincoln said:

The change that has taken place in naval vessels and naval warfare since the introduction of steam as a motive power for ships of war demands either a corresponding change in some of our existing navy-yards, or the establishment of new ones for the construction and necessary repair of modern naval vessels.

The necessity for such a navy-yard, so furnished, at some suitable place upon the Atlantic seaboard has, on repeated occasions, been brought to the attention of Congress by the Department.

The building, repairing, and fitting of naval vessels can now be done well and economically at this yard; the best evidence of which is the superior manner in which the work on the Juniata, Quinnebaug, and Ossipee has been executed, it not being excelled in any yard. The want of a good dock is seriously felt at this yard, which, with some modern tools for steel-ship building, would prepare the yard to commence such work.

The Bureau has again asked for an appropriation of $150,000 to enable it to purchase some of the most necessary tools to equip the League Island, Boston, Norfolk, Portsmouth, and Mare Island navy-yards for the purpose of building and repairing iron and steel ships. With the exception of the need of a few of the improved modern tools for these purposes, and the erection of plate and angle iron furnaces, there is no private establishment in this country which has better facilities, in all respects, for steel-ship building than the yards mentioned, and few which have as good.

The Brooklyn navy-yard is now in condition to commence and carry on, with some rapidity, the building of steel ships. The greatest efforts should be made to put all the other yards in the same condition with as much dispatch as possible.

The Government has means and appliances for carrying on all kinds of work connected with building, repairing, fitting, and equipping vessels of war which no private establishment could afford to have, and the character of the work done in its yards has never been questioned.

In case of a foreign war the Government would find that the same facilities and help could not be afforded it by private ship-builders as was furnished during our civil war, as most of the firms which then carried on wooden-ship building have ceased to exist; and to-day there are but few firms which, in the event of war, could commence and carry on, with any degree of rapidity, the construction of steel armored or unarmored vessels of war. It therefore becomes a necessity for the Government to put its yards in condition at once to meet any demand that might, in an emergency, be made upon it.

In the event of an appropriation being made for more steel ships, the Bureau hopes that at least one-half of the ships may be built in our navy-yards, in competition, as to cost and character of work, with outside establishments. It does not wish to be understood as opposing the building of naval vessels by private establishments under contract; it believes that one-half of the vessels appropriated for should be built by contract, but in competition with the Government navy-yards. The cost of work in the navy-yards can thereby be reduced, and the contractors and workmen in private establishments educated up to the requirements of a vessel for the naval service, which, at the present time, are understood by so few, as the work and fittings incident to such a vessel differ so materially from those of a merchant ship. By this means, in the event of a sudden call for vessels, private ship-builders would be capable of furnishing suitable ships for the naval service, while the Department, Bureau, and inspectors would have much less trouble in the execution of the work, and there would be less litigation than heretofore during and after the completion of the contracts.

One of the serious drawbacks at the present time, and one which, in the event of war, would cause us the greatest difficulty, is the need of better docking facilities.

At the present time the Essex is in the only dock at the Brooklyn navy-yard, and it is wanted to dock the Thetis, the latter vessel must either be put in a private dock or wait for six weeks for the Essex to be

repaired, so that she can be floated. This is the first yard in the country in point of size and importance, and it should have at least three docks. There can be no excuse that there are not good locations for them, as there are as good locations at this yard as could be wished for. Two modern wooden docks could be built, and in two years be ready for use.

A short time since it became necessary to dock the Tennessee, which was then at Hampton Roads, and as the dock at the Norfolk yard would not take a vessel of her length she was sent to New York. Certainly this condition of affairs should not be allowed to exist very long. The present dock should be lengthened, and one modern wooden dock, if not two of them, should be built at the Norfolk yard. Everything possible should be done to put this yard in first-class condition.

While the Portsmouth yard has a balance dock and marine railway, which will permit of taking a vessel out of the water and hauling her ashore, leaving the dock free to put another vessel on, there could, and should, be extensive alterations made to better its facilities. The dock basin should be enlarged so that at the head of it there would be three lines of ship-ways for building vessels on. When completed the vessels would be pushed down on the dock by the immense hydraulic ram now used there and the dock floated, and, when out of the basin, the newly-constructed vessel put afloat without danger of straining, as is often the case when vessels are launched. Buildings could then be placed over these slips, and all the necessary tools for ship work placed in them, with machinery and the necessary line shafting.

Independent of this a modern wooden dock, at least 500 feet long, should be built between the navy-yard island and Seavey's Island, which could be readily done at comparatively small cost. The water at its entrance would be ample for all docking purposes, and the natural excavation which now exists between the islands, with its solid-rock bottom, would very much reduce the expected outlay for this work.

At the Boston yard, the present dock should be lengthened, and two additional modern wooden docks built, there being the best possible facilities for this so far as good locations are concerned. Nothing is being done at this yard except caring for the immense stock of Government property now on hand there, and keeping in order the machinery and tools. This is one of the best, and probably the second best yard in the country; and if any new ships are to be built in the future in our navy-yards this yard should be utilized for that purpose. It has a fine set of buildings, first-class tools, and facilities of all kinds for doing work, and in its vicinity are to be found the best artisans in the country.

The Mare Island yard being the only one on the Pacific coast, should receive especial attention. Nothing that is now needed, or will be wanted in the future, to put this yard in a thoroughly effective condition for building or repairing iron or steel vessels, should be neglected. Independently of the stone dock now nearly completed, there should be built two modern wooden docks at least 500 feet in length.

The greatest necessity exists for having better docking facilities in in all the navy yards. This is rendered more important on account of the frequency with which the steel unsheathed vessels will be required to be docked to clean and paint their bottoms. In the event of a foreign war this great deficiency would be seriously felt; perhaps more so than any other of our present wants; it is therefore worthy of grave consideration whether immediate steps should not be taken to place our navy-yards, in this respect, in the most thorough condition of effectiveness. While other nations are increasing their docking facilities, which are

greater in one of the English dock-yards than in all of ours combined, we are doing nothing but theorizing.

The subject of building dry-docks is one which the Bureau of Yards and Docks has to deal with directly; but this Bureau having so long felt the necessity of having more docks to use, particularly larger and more modern ones, has undertaken to introduce the subject here.

The Naval Academy is much in need of another practice or school ship, to take the place of the Dale, which has been condemned; and I again recommend that the Ticonderoga, now at the Brooklyn yard, be converted and used for this purpose, by removing her boilers and engines, and making the berth deck continuous. She could be made to answer admirably, and could be utilized for the purpose for which such a vessel is needed; while, if sold, she will be entirely lost to the naval service, and the proceeds of sale would be turned into the Treasury.

In its last annual report the Bureau alluded to the mission of Naval Constructor Hichborn to Europe, collecting information and plans illustrating the most recent foreign practice in iron and steel ship-building. His report is now in the hands of the Department. It is eminently satisfactory, and is sure to be of great practical value. It considers the national dock-yards of Great Britain, Germany, Russia, and France, and contains descriptions, and in many places plans, of the important vessels building therein, devoting particular attention to such as seem to fulfill the peculiar requirements of our own service; and through his labors the Bureau is fully prepared to duplicate in all essential particulars the much-lauded Esmeralda or the Riachuelo, should it be decided that such vessels are required.

The details, fittings, and equipment of naval vessels abroad are fully treated of; and under this heading ventilation, sanitary arrangements, and the electric light receive due consideration.

The importance of torpedoes and torpedo boats led Constructor Hichborn to closely examine the yards of the well known English builders Thornycroft & Garron, and to compare their practice, with the result that the Bureau is now in possession of information upon this class of construction which will be of great utility should it be required to protect our coasts with a suitable flotilla.

In the British private ship-yards Constructor Hichborn was accorded opportunities of making thorough examinations of the several systems upon which the business is conducted, and his notes upon the management of labor in ship-yards, its wages, and the regulations to which it is subject, will be found of special interest. Much time was devoted to observing the improvements in shipbuilding tools, and a very complete collection of photographs of yard machinery, with prices by the leading foreign makers, enhances the general value of his work.

A number of large iron and steel works were examined, when such inspection could be accomplished without interfering with the main purpose of the tour. The growing use of steel castings in naval architecture received due investigation, and the principal armor-plate mills were visited, and important knowledge gained as to the making, shaping, and bending of heavy armor.

The Bureau takes pleasure in stating that Naval Constructor Hichborn was the recipient of the kind attentions of the leading naval architects abroad, to whose courteous liberality his mission owes a portion of its eminent success.

It is respectfully recommended that the report of Constructor Hichborn may be printed, in order that all who are interested in the affairs of the naval service may be benefited thereby.

In its annual report for 1883 the Bureau made allusion to the important subject of the education and appointment of assistant naval constructors. The consideration of this matter is so urgent, and the consequences of the present system so grave, that it is necessary to treat the subject at some length. The rapid extension of scientific methods in naval architecture has long been recognized. This Bureau years since expressed its opinion that "the highest education which we can give our assistant constructors will not be more than sufficient to enable them in the future to compete on fair terms with the constructors of England and France. But the term education must be understood in its fullest and broadest sense as comprising not only the science of naval architecture but the most thorough practical acquaintance with ship-yard management and manipulation. It is in supplying this requirement that our present method of recruiting the corps signally fails."

If it were necessary to support with authorities a proposition so obvious as a necessity of a double education for the naval architect, an education of the hands and eye and mechanical perception, as well as the mathematical and abstract functions of the mind, I might with propriety quote Mr. E. J. Harland, of the distinguished firm of Harland & Wolff, of Belfast, Ireland, when, in a discussion in the Institution of Naval Architects, he says:

> If the naval architect enters his profession and follows it out on scientific principles simply, he will make a great mistake; and if he follows it out from a shipbuilder's point of view he will make a mistake. He has to be scientific and he has to be practical. We must not lose ourselves in science. I should be the last man in the world to say a word against it, but I think at the present time we are apt to make too much of what is called education. We are educating our children above what it is probable they will ever be able to utilize in after life. I contend that the sons of ship-builders are over educated, and are apt to lose themselves in figures, because they are apt to follow the easier course of study, having books and papers before them, and neglect the workshop, and neglect coming in contact with those merchants who have to consider most carefully what classes of vessels will pay the best. I say that if a shipbuilder does not combine in his profession all these varied and sometimes opposing forces he will make a serious mistake and lower the value of his profession, not only as a profession, but also the value of it to the commercial community.

These remarks from one of the most progressive builders of the age, the pioneer in the construction of high-speed transatlantic liners, while mainly directed to the private ship-builders, seems to me in a great measure pertinent to those who are intrusted with the building of vessels for national defense.

It is impossible on this occasion to deal adequately with so ponderous a subject as technical education; briefly, let me be understood as its advocate within all reasonable limits, and not its opponent.

But one whose life has been spent in the earnest pursuit of his pro- n cannot see with indifference its rising members compelled to devote exhausting effort and a profligate sacrifice of time to acquire- nts which, so far as actual ship-building is concerned, are empty accomplishments and mere abstractions. He cannot, for instance, see spending four years at Annapolis learning languages and the sciences; then transferred to France and in the École Polytechnique pur- ıg similar studies for two years more—all of which six years' labor does not touch their profession, but is merely preparatory; and finally ending with two years at the School of Application, in Paris—one year to the marine engine and one to naval architecture. Yet this singular se is being followed by our two assistant constructors now in ice. Suppose a clear statement of these facts was submitted to a mittee of the leading practical men, such as actually conduct the great industries of the world, could any opinion be expressed other

than that such a course of education for any mechanical profession must be characterized as a marvel of perverted effort.

Valuable, nay, invaluable, as have been the deductions of science and especially of mathematical research as applied to naval architecture, I must express the opinion that much of what is considered deep professional learning is shallow scholastic pedantry, which can only embarrass its possessor when confronted with actual work. What is then required is the perfect knowledge of workmanship and material, the ready perception of their excellence or defect, knowledge of men and money, and fertility of mechanical resources. Yet in view of these most obvious and essential requirements, it is only necessary under our laws for a candidate to have passed creditably through the Naval Academy to be immediately appointed an assistant naval constructor; nor is there anything likely to prevent such men, without practical experience nor perhaps natural fitness, being intrusted at an early date with vast and complicated constructions of the future navy, and regulating the expenditure of large sums of the public money.

By foreign nations this matter is better understood. The indispensability of practical knowledge is recognized. With their constructors experience and theory go together. In the instruction of their rising men practice precedes theory, as it properly should. Thus in the English dock-yards every shipwright apprentice has before him the possibility of rising by diligence and application to the highest position and emoluments in the construction corps. By an admirable system of dock-yard schools, which all the apprentices are required to attend, and from which limited numbers of the most promising are, from time to time, selected for the advanced course at Greenwich, the Government secures the best material available for its future constructors, while the dock-yard employés are made an unusually intelligent class. In contrast to this, the Annapolis graduates are thrust upon the construction corps without practical knowledge of ship-yard procedure and devoid of that all-important quality, experience in the management of men; nor is there sufficient stimulus to obtain these qualities when they are once entered upon what is too probably an assured future.

The distinguished naval architects abroad, to whom the profession owes so much of its dignity and its wonderful advancement, are the offspring of no such system. Sir Edward J. Reed, Sir Nathaniel Barnaby, and William H. White, esq., the successive directors of naval construction of the Royal Navy, rose from dock yard apprentices under the wise policy which I have above described. They are typical naval architects, worthy of the emulation of the profession in all countries, and we cannot do better in a revision of the methods of recruiting the construction corps than to consider the admirable course by which such men have been produced. Our present system is calculated to develop a class of tyros in naval construction, who will discuss scientific ship-building with mystifying verbosity, but will handle real work with blundering incapacity and failure.

Accompanying this report please find the information called for by section 429, Revised Statutes, and the third section of the naval appropriation act approved January 30, 1885.

I am, sir, very respectfully, your obedient servant,

THEODORE D. WILSON,
Chief Constructor, U. S. Navy, Chief of Bureau.

Hon. W. C. WHITNEY,
Secretary of the Navy.

Vessels repaired at the different navy-yards during the fiscal year 1884-'85.

Alliance, Adams, Brooklyn, Constitution, Camanche, Dale, Despatch, Emerald, Fortune, Galena, Intrepid, Leyden, Marion, Mayflower, Miantonomoh, Minnesota, Mohican, Monongahela, Monterey, Nantucket, New Hampshire, Omaha, Passaic, Pensacola, Phlox, Pinta, Portsmouth, Powhatan, Ranger, Saratoga, Speedwell, Swatara, Tallapoosa, Tennessee, Vandalia, Vermont, Wyoming, Yantic.

Contracts made during the fiscal year 1884-'85.

Merritt Wrecking Organization contract; dated August 30, 1884; raising the Tallapoosa, $35,000.

Sampson & Peterson; contract dated October 1, 1884; weatherboarding the New Hampshire, $6,798.

Milliken & Smith; contract dated February 26, 1885; steel castings for the Miantonomoh; estimated cost, $14,636.

Appropriations for fiscal year 1884-'85.

CONSTRUCTION AND REPAIR.

Appropriated		$1,050,000 00
Expended:		
For labor at navy-yards and stations	$695,954 88	
For the purchase of materials and tools for yards, advertising, foreign postage, telegrams, books, plans, instruments, &c., for drawing-room	290,499 08	
For bills paid on account foreign stations	36,394 40	
		1,022,848 36
Balance July 1, 1885		27,151 64

CIVIL ESTABLISHMENT.

Appropriated	20,000 00
Expended:	
For clerks and writers at navy yards	17,815 25
Balance, July 1, 1885	2,184 75

STEEL CRUISERS.

Appropriated	996,857 23
Amount received from transfers	40,177 09
	1,037,034 32
Expended:	
On account of steel cruisers	740,933 05
Balance July 1, 1885	296,101 27

DOUBLE-TURRETED MONITORS.

Expended:	
On account of the Miantonomoh	174,733 86
Balance July 1, 1885	27,280 07

Cost of stores on hand at the different navy yards.

PORTSMOUTH, N. H.

On hand July 1, 1884	$578,562 00
Received during the year ending July 1, 1885	112,276 00
Total on hand and received	690,838 00
Expended during the year ending July 1, 1885	114,678 00
Total on hand July 1, 1885	576,160 00

BOSTON.

On hand July 1, 1884	$1,291,
Received during the year ending July 1, 1885	67,
Total on hand and received	1,358,
Expended during the year ending July 1, 1885	39,
Total on hand July 1, 1885	1,319,

NEW YORK.

On hand July 1, 1884	1,392,
Received during the year ending July 1, 1885	255,
Total on hand and received	1,648,
Expended during the year ending July 1, 1885	267,
Total on hand July 1, 1885	1,380,

LEAGUE ISLAND.

On hand July 1, 1884	397,
Received during the year ending July 1, 1885	2,
Total on hand and received	400,
Expended during the year ending July 1, 1885	9,
Total on hand July 1, 1885	391,

WASHINGTON.

On hand July 1, 1884	167,
Received during the year ending July 1, 1885	121,
Total on hand and received	288,
Expended during the year ending July 1, 1885	71,
Total on hand July 1, 1885	217,

NORFOLK.

On hand July 1, 1884	629,
Received during the year ending July 1, 1885	52,
Total on hand and received	682,
Expended during the year ending July 1, 1885	74,
Total on hand July 1, 1885	607,

PENSACOLA.

On hand July 1, 1884	334,
Received during the year ending July 1, 1885	
Total on hand and received	334,
Expended during the year ending July 1, 1885	
Total on hand July 1, 1885	334,

MARE ISLAND.

On hand July 1, 1884	367,
Received during the year ending July 1, 1885	44,
Total on hand and received	412,
Expended during the year ending July 1, 1885	51,
Total on hand July 1, 1885	360,

Amounts expended for civilians employed on clerical duty.

[Information called for under section 3, of the act approved January 30, 1885.]

mths.	Kittery.	Boston.	New York.	League Island.	Washington.	Norfolk.	Pensacola.	Mare Island.
884.								
....	$731 42	$248 90	$1,008 56	$997 20	$861 79	$672 17	$86 06	$557 43
....	743 49	265 45	1,046 40	1,047 81	917 18	693 55	86 06	557 44
er	740 10	326 13	1,012 90	975 80	860 80	702 71	86 06	550 04
....	767 42	343 27	1,077 92	1,076 04	852 48	778 37	89 37	570 05
er	670 17	312 82	812 32	1,005 42	839 80	706 50	79 44	524 80
er	627 42	333 27	815 80	960 00	1,448 08	673 85	86 06	557 44
885.								
....	630 85	343 27	682 47	988 48	1,536 15	614 16	86 06	40 03
y	565 43	286 98	745 45	863 62	1,463 23	617 30	79 44	888 30
......	617 49	248 90	812 49	999 16	1,421 79	677 26	86 06	179 65
...	649 10	245 07	789 60	1,147 76	1,843 74	656 63	86 06	550 04
....	527 61	238 90	702 56	1,192 73	1,612 80	596 22	86 06	662 73
..	515 98	245 09	773 60	1,232 41	1,879 63	679 06	86 06	224 92
	7,785 48	3,438 05	10,280 25	12,486 52	15,538 22	8,070 04	1,022 70	5,862 38

Total, $64,504.61

Estimates of appropriations required for the service of the fiscal year ending June 30, 18 by the Bureau of Construction and Repair.

A.—SALARIES.

	Estimated amount which will be required for each detailed object of expenditure.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the current fiscal year ending June 30, 18[illegible].
Chief clerk	$1,800 00		
Draftsman	1,800 00		
One clerk of class four	1,800 00		
One clerk of class three	1,600 00		
One assistant draftsman	1,400 00		
One clerk of class two	1,400 00		
One clerk of class one	1,200 00		
One assistant messenger	720 00		
One laborer	660 00	$12,380 00	$12,380
Increase of salary of chief clerk (submitted) NOTE.—The chief clerk, under the law, acts as chief of Bureau in case of the death, illness, resignation, or absence of that officer, and must be competent to take charge of the Bureau. The duties of this office are arduous, and fully deserve the salary herein estimated, it being the same amount ($2,250) paid to chief clerks in other Departments who are authorized to act in the absence of their chiefs.	450 00		
Increase of salary of draftsman (submitted) NOTE.—As the duties and responsibilities of the draftsman of this Bureau are certainly much greater and of more importance than those of the draftsman of the Bureau of Steam Engineering, who is paid $2,250 per annum, this increase is submitted as just and proper in the case.	450 00		
Increase of pay of assistant draftsman, who now receives less than is paid per diem draftsmen in navy yards, and whose duties are about the same (submitted)	200 00		
Three draftsmen, at $1,600 per annum (submitted)	4,800 00		
Restoring assistant messenger to rank of messenger with pay of such (submitted)	120 00	6,020 00	

B.—CONSTRUCTION AND REPAIR OF VESSELS.

Preservation and completion of vessels on the stocks and in ordinary, purchase of materials and stores of all kinds, labor in navy-yards and on foreign stations, purchase of machinery, rights of patented articles, and tools for use in shops, wear, tear, and repair of vessels afloat, and for general care, increase, and protection of the Navy in the line of construction and repair; incidental expenses, such as advertising, foreign postages, telegrams, photographing, books, plans, stationery, and instruments for drawing-room (appropriated)	$2,000,000 00	$2,000,000 00	$1,000,000

C.—DOUBLE-TURRETED MONITORS.

Completing four double-turreted monitors, as follows:			
Puritan (appropriated)	$955,842 00		
Terror (appropriated)	627,288 00		
Amphitrite (appropriated)	630,584 00		
Monadnock (appropriated)	701,442 00	$2,915,156 00	

D.—INCREASE OF THE NAVY.

Building of hulls of new steel vessels	$5,000,000 00		

Estimates of appropriations required for the service of the fiscal year, &c.—Continued.

E.—CIVIL ESTABLISHMENT.

	Estimated amount which will be required for each detailed object of appropriation.	Total amount to be appropriated under each head of appropriation.	Amount appropriated for the current fiscal year ending June 30, 1884.
At the navy yard, Kittery, Me.			
One clerk to naval constructor (appropriated)	$1,400 00		
One clerk of store houses (appropriated)	1,300 00		
		$2,700 00	$2,700 00
Three writers, at $1,017 25 each (submitted)	3,051 75		
One draftsman, equal to $5 per day (submitted)	1,565 00		
		4,616 75	
At the navy yard, Boston.			
One clerk to naval constructor (appropriated)	1,400 00		
One clerk of store-houses (appropriated)	1,300 00		
		2,700 00	2,700 00
Three writers, at $1,017 25 each (submitted)	3,051 75		
One draftsman, equal to $5 per day (submitted)	1,565 00		
		4,616 75	
At the navy yard, Brooklyn.			
One clerk to naval constructor (appropriated)	1,400 00		
One clerk of store houses (appropriated)	1,300 00		
		2,700 00	2,700 00
Three writers, at $1,017 25 each (submitted)	3,051 75		
Two draftsmen, equal to $5 per day each (submitted)	3,030 00		
		6,081 75	
At the navy yard, League Island, Pa.:			
One clerk to naval constructor (appropriated)	1,400 00		
One clerk of store-houses (appropriated)	1,300 00		
		2,700 00	2,700 00
Three writers, at $1,017 25 each (submitted)	3,051 75		
One draftsman, equal to $5 per day (submitted)	1,565 00		
		4,616 75	
At the navy yard, Washington.			
One clerk to naval constructor (appropriated)	1,400 00		
Two writers, at $1,017 25 each (appropriated)	2,034 50		
		3,434 50	3,434 50
One clerk of store houses (submitted)	1,300 00		
One draftsman, equal to $5 per day (submitted)	1,565 00		
		2,865 00	
At the navy yard, Norfolk.			
One clerk to naval constructor (appropriated)	1,400 00		
One clerk of store houses (appropriated)	1,300 00		
		2,700 00	2,700 00
Three writers, at $1,017 25 each (submitted)	3,051 75		
One draftsman, equal to $5 per day (submitted)	1,565 00		
		4,616 75	
At the navy yard, Pensacola, Fla.			
One clerk of store houses (submitted)	1,300 00	1,300 00	
At the navy yard, Mare Island, Cal.:			
One clerk to naval constructor (appropriated)	1,400 00		
One clerk of store houses (appropriated)	1,300 00		
		2,700 00	2,700 00
Three writers, at $1,017 25 each (submitted)	3,051 75		
One draftsman, equal to $6 per day (submitted)	1,878 00		
		4,925 75	
Total		63,278 00	*19,634 00

*$20,000 was appropriated in bulk to the Bureau.

No. 14.—REPORT OF THE ADMIRAL OF THE NAVY.

OFFICE OF THE ADMIRAL,
Washington, D. C., November 30, 1885.

SIR: I have the honor to submit the following report of inspections since November, 1884:

Vessels in commission, inspected in order to ascertain their general efficiency.

Name.	Date of Inspection.	Name.	Date of inspection.
Essex	Jan. 2, 1885	Omaha	June 7,
Marion	Feb. 17, 1885	Iroquois	......
Lackawanna	Mar. 24, 1885	Brooklyn	Nov.
Pensacola	May 7, 1885		

Vessels examined under section 2, act of August 5, 1882.

Name.	Remarks.
Rose	Condemned and sold.
Wachusett	Condemned and not sold.
Pilgrim	Do.
Dale	Condemned as unfit for sea-service, but useful as a receiving ship, and is now so employed.

I beg leave to call your attention to the condition of the iron-clads at City Point, Virginia.

Name.	Remarks.
Saugus	Requires extensive repairs, the cost of which would not be less than $196,000.
Wyandotte	Requires some small outlay to guard the vessel and her outfits from deterioration when she is laid up in ordinary.

The remaining iron-clads require repairs, as shown in the following table:

Name.	Estimated cost of repairs.	Time necessary.
Montauk	$23,996 68	Sixty working days.
Jason	36,113 06	Do.
Nahant	35,806 06	
Ajax	15,710 00	Thirty-five days.
Canonicus	19,502 00	Forty-five days.
Catskill	6,625 00	Thirty days.
Lehigh	10,526 00	Six weeks.
Mahopac	7,853 00	Five weeks.
Manhattan	10,445 00	Six weeks.

bove-named iron-clads could be made very serviceable in time protecting such places as must be subject to attack by light- cruisers; or if armed with rifled guns, they would be efficient 's of the approaches to Washington.

ass of vessels, it is true, is rather out of date, but they have ls and engines capable of moving them from place to place; heir boilers were in proper condition they would be useful in g rivers and harbors where heavy iron-clads could not get at

tions have vessels in their navies of a somewhat obsolete type, course, are not as efficient as ships of later construction, but ot throw them aside. On the contrary they keep them in good d ready for service, for there would always be some position ey could be made useful especially when provided with long- ns. We have such a shadow of a Navy that we cannot afford away anything in the shape of an iron-clad, and those that we home defense are worth more than all the wooden vessels in ce.

remarks are still more applicable to the Amphitrite, Miantono- nadnock, Puritan, and Terror, turreted vessels under construc- ch, if finished will be valuable additions to the Navy. When finished and fitted with modern batteries, there will be no bet- ls of this class in any navy, for home defense, which is the only atshould be expected of them, although their capacity to cross and encounter the most tempestuous weather has been fully ated.

years ago, when we were on the verge of a war with Spain, rs of the Navy would have been much better satisfied if these ad been in condition for service.

they now be completed they would give such a prestige to the it has not enjoyed for twenty years, and though far from furn- the power required for the protection of our coasts, their com- ust show a desire on the part of Congress to begin the recon- of the Navy at the point where it is most needed, viz, the n of our coast, which is now at the mercy of foreign powers.

uch a nucleus of a force as these monitors completed would here would be much greater hesitation on the part of an ene- lesting our sea-board cities.

ns to me to be bad policy to leave the monitors in their present . We cannot afford to throw them away. We cannot sell hey are, and they are deteriorating by being kept in an unfin- te.

ong continued observation I am satisfied that the strictures regard to the construction of these vessels are very unjust. the work has gone they are better vessels than the originals ey represent, and which at the time they were built were con- be remarkably efficient, either one of them being more than for any contemporary European iron-clad.

three millions of dollars are, I believe, required to finish the s, and when they are completed and properly armed we will at e taken an important step towards the resurrection of a Navy one time was one of the best equipped in the world.

year adds to the deterioration of the vessels in question, and ntly increases their cost. They are now in that state when be completed with all the modern improvements, without

altering the work already done, and with but little more expense than was originally estimated.

It is very well to build cruisers, but the first consideration is the protection of our seaboard cities, which, at this moment, are defenseless, for it is well known that our forts could offer little resistance to powerful iron-clads.

These defensive works which were built years ago were quite eq to their purpose, but are now useless against the artillery of to-day. Their walls, pierced for guns long since out of date, could offer no resistance to an eight hundred-pound rifle shot, which would demolish everything in its path.

The best illustration I can give of the power of modern artillery when used against masonry is the attack of General Gillmore on Fort Sumter, when, with sixty rifled guns, the largest a hundred pounder, operated from a distance of five thousand yards, he reduced the work to a heap of ruins.

The forts defending the city of Alexandria, in Egypt, although built in the most scientific manner and armed with the best rifled guns, were so battered by a fleet of English iron-clads, that in a short time guns, forts, and city were at its mercy.

In considering our fortifications and naval vessels it is difficult to determine which are the most behind the times; but all the forts we have at the Narrows in New York Harbor and all our present available Navy could not prevent two first-class iron-clads from entering the harbor and laying the city under contribution.

These forts could not keep off our iron-clads if they belonged to an adversary; another fact which shows how useful the monitors would be in conjunction with the defenses on shore.

In other days, when wooden ships and smooth-bore guns decided matters on the high seas, ships could seek the protection of forts; but hereafter forts will require the aid of iron-clads to keep off other ironclads.

Even wooden vessels have often proved more than a match for the strongest forts. Sir John Duckworth passed the batteries of the Dardanelles, which mounted guns throwing eight-hundred-pound balls of stone; Nelson with his fleet captured the defenses of Copenhagen: Lord Exmouth with his wooden ships swept the formidable batteries of Algiers from one end of the city to the other; the French at San Juan de Ulloa knocked those heavy works to pieces; and, to crown all, the wooden ships of the United States Navy, from 1861 to 1864, armed with smooth-bore guns, silenced and captured one fortification after another, though planned by the most skillful engineers and bravely and scientifically defended.

The present forts of the United States have fallen so much behind the times, that our engineers are quite aghast at the expense required to bring them up to the latest standard of efficiency.

Although our defensive system in fortifications and ships is the worst in the world, there is a chance to improve it by the completion of the monitors under discussion, and I earnestly hope that while we are appropriating money for cruisers—which may or may not answer the purpose of their construction—the iron-clads will not be neglected.

In all the calculations made year after year for the improvement of the Navy, the necessity of torpedo-boats seems to be ignored. We indeed take great pains to fit out our high-pressure steam-launches with clumsy apparatus supposed to be all-sufficient to destroy a ship. Foreign officers must smile when witnessing the vain efforts of these six-

›t launches to blow up a barrel which is intended to represent an ron-clad armed with a sufficient number of machine-guns to cripple an ordinary ship of war in ten minutes.

The time has passed when an ordinary steam-launch can excite much apprehension in the mind of any European officer who has been educated in a torpedo system that puts our crude and far from ingenious tempts to shame.

All foreign navies are at the present time giving great attention to the subject of torpedoes as the one thing likely to prove a match for the otherwise invincible iron-clad. Small torpedo-boats will be superseded in a great measure by the introduction of torpedo-ships, when every vessel will fire her own torpedoes, not only from her bow and ern, but from her sides under water.

Foreign naval powers do not build torpedo vessels by ones and twos, but by the quantity. Enter an English or French dock-yard port and you will find dozens of these formidable vessels flitting about like meteors, with speed greater than that of any others, and ever ready for tive service.

This is the one thing the iron-clad of to-day has most to fear, since it the most difficult to avoid.

In England the torpedo system has culminated in the Polyphemus, ship on which the Government has spent, up to the present time, over a million dollars in experiments alone, endeavoring to combine in vessels of this class a system of torpedo attack the most destructive that has ever been devised.

These experiments will show that every ship of war should be a torpedo vessel as well as a gunboat and ram, and we could obtain much valuable information by having the officer detailed as naval attaché to the United States legation give his particular attention to this subject.

The Government of the United States makes no experiments in this direction, and therefore we should avail ourselves of what is being done abroad.

Private individuals in this country have received so little encouragement from Congress and from the Navy Department as to become discouraged, perhaps on the threshold of some important discovery. Instead of encouraging our own officers and citizens, we prefer to adopt he inventions of foreigners, which are no better than can be found at home, ignoring that which if encouraged would give us a fair start in he torpedo line.

We have now within the waters of this country one of the best devices or torpedo warfare ever yet invented. This is the Destroyer, a small vessel fitted with a submarine gun, the principle of which is, in my opinion, the groundwork of the torpedo-boat of the future.

Mr. John Ericsson has spent a fortune on this vessel of his invention, but his device does not seem to have met with that favor which would be expected from our intelligent naval officers.

Mr. Ericsson has been required to bear the expense of the exhaustive experiments which have been made before different naval boards, the only result of which has been to cause a doubt as to the benefit of so many Boards, and to disgust the ingenious inventor at the little encouragement he has received, to say nothing of actual damage inflicted.

Mr. Ericsson has, in the course of his life, been subjected to an immense amount of investigation, and now, in his eighty-third year, he naturally objects to further experiments at his own expense. After he had paid the expenses of one fair trial, the Government should pay for l the others.

The Destroyer is still in Mr. Ericsson's hands, after having proved herself a valuable invention, and it is due to this distinguished man, who did so much in 1862 to save the honor of our Government, that his vessel be purchased out and out, and that he be reimbursed for the expenses to which he has been subjected.

Such a course would encourage him and others to proceed with their inventions in the torpedo line, and Mr. Ericsson would doubtless bring his invention to perfection when he found himself reaping the reward to which he is entitled.

There should be established in the Navy a torpedo corps afloat, for coast and harbor defense. Districts should be designated from Maine to Texas, and officers should be attached to the corps for a period of at least three years each. The work could be established on a small scale at first, say at Boston and New York, and extended as necessity required.

This is the only way to familiarize officers of the Navy with the practical workings of the torpedo, and at the same time foster the different valuable inventions that may present themselves. Such trials of the great factor in war by those constantly employed in its application are the only methods of obtaining practical results. This kind of duty would be strictly professional, which can hardly be said of employment on the Fish Commission or as attachés of the Navy Department and Smithsonian Institution. Under such a system the torpedo would be thoroughly understood in the Navy, which is not the case at present, as little is learned from the few experiments witnessed at the torpedo station.

In time of war the defense of our coasts and harbors by torpedo boats will naturally come under the direction of sea-going people, *i. e.*, naval officers, and this kind of warfare is what an enemy will have most to fear, for although a ship at sea may be able to defend herself against the attacks of torpedo-vessels by means of her Hotchkiss guns, it would be much more difficult for her to do so if attacked in the narrow entrance to a harbor by boats darting from every quarter with a speed that would render escape impossible. Ships of war may pass unharmed over beds of torpedoes which from want of care or skill in their management have been rendered harmless, but they can hardly escape the assault of swift torpedo-boats in narrow or tortuous channels.

The question of torpedo-boats is so important that I do not hesitate to recommend that twenty of them be built without delay to be fitted with simple and well-tested apparatus, no vessel to be smaller than 150 tons displacement.

Twenty such vessels of great speed and fitted with the Ericsson torpedo would make it hazardous for an enemy cruising on our coast, and would be an excellent investment of money. At the same time I repeat my recommendation that Mr. Ericsson be paid the amount asked for from Congress by several Secretaries of the Navy, to reimburse him for his outlay in building the Destroyer, which in my opinion can be made the most efficient torpedo boat that has yet been constructed.

I beg leave to call your attention to certain defects in our naval system which should be remedied. To be efficient the Navy should be organized in all its branches on a system where there could be no clashing of interests and where anomalous conditions could not exist.

At Newport, R. I., there are representatives of three branches of naval administration within a short distance of each other: The war college, under a rear-admiral; the apprentice training-ship New Hampshire, commanded by a captain; and the torpedo station, under a commander—three separate and distinct organizations.

The rear-admiral commanding the war college has no official recognition from either of his juniors, nor do these latter officers officially recognize each other. All this is contrary to what has always been the policy of the Navy, as in this case the true position of the ranking officer has been entirely ignored.

The war college is under the control of the Bureau of Navigation, the training-ship is under the Bureau of Equipment, and the torpedo station under the Bureau of Ordnance.

This classification is all very well so far as providing for the needs of the several Departments is concerned; but the senior officer, whoever he may be, should in such cases be recognized as the senior officer of the station, and should hoist his distinguishing flag as such.

Orders and communications should be forwarded through him, and he should be the officer called upon by the commanders of visiting ships of war.

The chances are that the war college will continue to be presided over by an officer senior in rank to the others; and for the sake of uniformity in the service, I recommend that he be made "senior officer of the station," and continue to make such recommendations for the benefit of the service as the Navy Department may from time to time require.

The way I have suggested seems to be the only one to arrange different departments so situated without ignoring rank in the Navy, the present course being the most injurious that could be adopted, as it is calculated to break down the discipline of the service, which always suffers when rank is ignored or where the position of a senior officer is not precisely defined.

Our Navy can only preserve its prestige by paying proper respect to rank, which has been gained by years of hard service, and it offers a bad precedent when an officer of high rank holds a position in no way superior to two others in his immediate vicinity, who are several grades below him.

There can be no valid reason why rank in one place should not have what it is entitled to as well as in another. It would be an anomaly for the commandant of the New York navy-yard to have a junior in command of the receiving-ship, and independent of his control, or to have the ordnance officer in independent command of Cob Dock. The recognition of seniority, under all circumstances, will be found the best system in the long run, and I therefore strongly advocate it.

The Naval War College of to-day is but the beginning of an institution that will in the future, I believe, confer great benefit on the service.

There are some officers who retard its progress by their opposition, yet no one can give a single good reason why such an institution should not be maintained.

I have had as much to do with graduates from the Naval Academy as any one, and I do not hesitate to say that the academic course does not and cannot thoroughly prepare an officer for all the high duties he will be called upon to perform.

If I were selecting officers in time of war I should certainly give the preference to those who had gone through a course at the torpedo school and war college, for the reason that in the studies which young officers will pursue at these post-graduate institutions they will have brought before them in practical form many things that they had previously only learned theoretically, and perhaps indistinctly remembered.

A naval officer of the present day to be eminent in his profession must be a constant student, and where could he have such an opportunity of becoming acquainted with all the improvements, modifications

and experiences in the art of war as by a course of study at the war college? Officers of the Navy should seek all sources of information to fit themselves for the high duties of the future. Those who oppose this school because they can no longer benefit by it, or for other undefined reasons unworthy of consideration, should be content to let the Navy Department exercise its own judgment in the matter and not endea to throw obstacles in the way of a valuable institution.

No good reason can be advanced why our naval officers should not have an opportunity of perfecting themselves in professional matters which will at least keep them on an equality with officers in foreign navies.

I consider that the education received by cadets at the Naval Academy is merely the groundwork to fit them for what they will have to learn practically in the future.

As the war college is made more attractive to students by the consideration of interesting professional subjects—on which few young officers are sufficiently well informed—it will afford full instruction in professional science, and impart that general information without which a naval officer cannot be considered fully qualified to supervise the important matters which constantly claim his attention.

Ever since you assumed charge of the Navy Department you must have perceived the necessity of reorganizing the whole Navy.

No material change has been made in the organization of the Navy Department since 1842, and the changes made at that time were not provements.

A new arrangement of the service can easily be made without disturbing its balance, for the education of naval officers enables them to adapt themselves quickly to any change in the surrounding conditions.

The necessary reforms could best be ascertained by convening a board composed of the senior officers of the Navy, who have had long years of experience, who have the best interests of the service at heart, and who could not be deterred from plainly expressing their sentiments.

These reforms should extend to all branches of the military administration of the Navy, and by taking a fresh departure at this time the naval service might continue a number of years until changes more radical than any we have yet witnessed shall demand another reorganization.

The Navy has been allowed for years to run in a rut, and not even a formidable war could eliminate the defects from the bureau system.

In 1861 it was found necessary to call in an expert, an ex-naval officer, to supervise, as Assistant Secretary, the workings of the Bureaus, wl action for a long time had been far from harmonious.

The Bureau system would work well enough if the different departments were under the immediate supervision of a Board of Control, which, under the direction of the Secretary of the Navy, should have the management of such professional matters as might be unfamiliar to the head of the Department.

No better method of carrying on the *details* of naval administration could be desired than the Bureau system, but there should be a professional administrative board of officers not below the grade of commodore to aid the Secretary of the Navy in carrying on the duties of his office, ready at all times to furnish him with any information he might require relating to the service.

This is a method analogous to that which prevails in European navies, under which they have attained to a perfection which we can hardly hope to rival under our present circumstances.

When the present Bureau system was proposed it was the intention to thereby relieve the Board of Naval Commissioners of a great amount of detail labor which it was difficult for them to properly supervise. The commissioners were to remain as the administrative assistants of the head of the Department, to supervise all branches of the service under his direction. Owing, however, to the intrigues of an officer who desired to manage his own department without interference, the Board of Naval Commissioners was omitted from the new plan, which thus became like the play of Hamlet with Hamlet left out!

No objection can be made to most of the officers who have served as chiefs of Bureaus; the fault is in the system.

The personnel of the Navy Department is sufficient to conduct the affairs of half a dozen navies if it was properly organized. In the latter case Advisory Boards outside the Department could be advantageously dispensed with. The chances are that better ships would be built by the Bureaus under the supervision of a Board presided over by the Secretary of the Navy than in any other way.

Such a system would preserve harmonious action, while the action of outside Advisory Boards leads to antagonism.

The Board of Navy Commissioners, by the judicious exercise of their authority, built up our Navy, and kept it in advance of others in regard to the efficiency of their ships.

Since the Board of Commissioners was abolished it has not been found possible with the Bureau system alone to keep our navy up to anything like an equality with the navies of other powers. If this were not the case, why is it that since the close of the civil war we have not constructed a single modern iron-clad or a cruiser that will compare with those of foreign navies?

At the present time we have literally nothing in commission but so-called "vessels of war" that can scarcely perform the duties of a peace establishment, and in case of a conflict with any naval power the aforesaid war vessels would have to go into retirement until peace was declared, the largest of them having neither speed nor battery that would enable her to contend successfully against a two-gun modern French or English gunboat.

The Bureaus, no doubt, do all they can under the present system to build up the Navy and keep it in order, but they do not advocate the introduction of a board of naval commissioners, which would lighten their labors and bring about a unity of action, such as is at present quite out of the question.

The Bureaus are not invested with separate authority by Congress, but are simply to perform such duties as are assigned them by the Secretary of the Navy. They can do little towards maintaining discipline, regulating the management of ships in commission or of navy-yards, for each chief of Bureau is absorbed in the duties of his own office, and the labor is so continuous that he has no time to turn his attention to general subjects connected with the Navy.

If a chief of Bureau had the time, he would have no power to carry out his plans, even if he were not considered as interfering in matters which did not concern him.

During a service of nearly fifty-seven years I have had ample opportunity of seeing the workings of our two systems of naval administration.

The system of Navy Commissioners was defective for want of the Bureaus to carry out the detail work of the service, while the Bureau system without a board of commissioners to advise the Secretary in matters

with which a civilian is not expected to be familiar is still more defective.

It has been proposed that the Secretary of the Navy should have a legally authorized adjutant or assistant secretary appointed from among the officers of the Navy, but the plan for a board of commissioners is superior to this arrangement in every respect. The one-man power as advisory is not so good as when the authority is divided among three persons, who are checks upon each other as regards favoritism and injustice.

Besides, the advice of three persons is more apt to be judicious than that of one alone.

I am an impartial judge in this matter, because it does not personally affect me. My position separates me from any connection with these posts, and my age precludes the idea of my undertaking any laborious duty. For upwards of a year I served in the Navy Department in the capacity of Assistant Secretary or adviser of the Secretary of the Navy on professional matters. That short period gave me a full knowledge of the defects of the Bureau system, and at the same time satisfied me that a naval officer, no matter what his rank might be, had no business in the Department as assistant secretary or professional advisor. He would soon lose all his friends and would make hosts of enemies. He would have to bear the blame if anything went wrong, and would receive no credit for any good that he might accomplish.

If I in a measure escaped such a fate, it was because I endeavored to interfere with no one in the Department, and my connection with it was comparatively brief.

The only thing I gained by my service there was an intimate knowledge of the workings of the Bureau system, and from that time to this I have constantly advocated a change, since I am of opinion that until a change takes place the Navy cannot be properly administered, and this I affirm without the least intention of depreciating the many able officers who have held the position of chief of Bureau; numbers of them have been my personal friends, and with all of them my relations have been pleasant.

I must beg leave to make a recommendation which I think, if acted upon, will increase the efficiency of the service and prove gratifying to its older officers. Until a recent period it has been customary to place only rear-admirals in command of squadrons, but as there are too few officers of this rank on the active list to follow out this rule, we are now adopting the plan of employing commodores with the appointment of acting rear-admirals.

This is a good idea, for by so doing the Department can avail itself of the services of a younger set of officers, to whom the duties of command afloat are more congenial than they are to those who have nearly reached the age for retirement; but it is unjust that an officer with the rank and command of a rear-admiral should not have the pay of that grade, without which he cannot properly maintain his position. He must either decline invitations which are given him as a mark of respect to his country or impoverish himself in the effort to properly reciprocate such civilities.

In the principal navies of the world the commanding officer of a fleet or squadron is allowed a sufficient sum, in addition to his pay proper, to enable him to return the civilities extended to foreigners, and he is required to expend this allowance in such a manner as to cement the friendly relations existing with the different countries. If such an allowance were made to our officers, a commodore could afford to accept

command of a squadron, but at present they cannot do so without the risk of seriously hampering themselves.

It is unjust to compel an officer to defray the expense of entertaining those who are in fact the guests of the nation out of his limited pay; and I think we are the only naval power that deals so illiberally with its officers in this particular.

I must further recommend that navy-yards and stations, instead of being under the command of commodores, should, as far as possible, be given to rear-admirals. Officers of the latter grade do not, as a rule, enjoy their rank more than a year or two before the time arrives for them to go on the retired list, and their last command, considering their years, should be at a shore station.

This seems to be the rule at the English and French naval stations, where the experience of many years has shown the justice and utility of such a course. In such matters as these our Navy suffers by comparison with others; for our system, or rather want of system, will not stand the test of criticism.

I had no opportunity this year of inspecting the North Atlantic squadron, as the vessels of which it is composed were scattered about, and the venerable flagship Tennessee was generally at a navy-yard repairing her boilers or patching the hull, which in a few years must be consigned to the scrap heap for want of repairs that are limited by law.

The place of the Tennessee should be filled. With the exception of the Trenton and the Lancaster she is the only ship of respectable size now afloat in the Navy. Her condition and that of other vessels is a sad commentary on naval management in the United States, which is supposed to be a progressive nation, but which, in fact, is wofully lacking in defenses of its coasts and commerce.

Our mercantile marine—what is left of it—has frequently to apply for assistance to foreign ships of war which assistance is cheerfully given.

It is sometimes intimated that the Navy is to enter upon a new era, that the service is to be rehabilitated, and that the flag of the Union is once more to be carried at the peak of such vessels as will command the respect of the world; but this cannot be done in a twelvemonth, nor in the way lately adopted by Congress of closely defining the character of the ships to be built.

While the Board of Navy Commissioners was in existence there was allowed by Congress for a series of years a certain amount to be annually expended for the general improvement and increase of the Navy. In that way we obtained a fleet of fifteen ships of the line, some thirty or forty other fine vessels, and a vast amount of valuable material accumulated year after year for contingencies, which supplied the Navy during the civil war, and without which the Navy Department would have been sadly hampered. The same method should be revived, and an amount annually appropriated by Congress for the gradual increase of the Navy, without attempting to define the tonnage of each vessel.

In the course of a year it may become important to change the general plan of a ship on the stocks, and the Navy Department should be left at liberty to construct vessels of a size and arrangement best suited to the circumstances existing.

So rapid are the changes in naval warfare, that what appears to-day a superior vessel may to-morrow be superseded by a different type.

I have read in the newspapers of several classes of vessels proposed for the Navy, but varying so greatly in tonnage as to multiply in too great a degree the different sizes.

There should be the following classes of cruising ships in the Navy:

Grade.	Tonnage.	Horse-power.	Speed.
			Knots.
Class 1	7,000	9,750	18
Class 1	5,000	6,800	18
Class 1	3,500	5,800	18
Class 1 (gunboats)	1,600	3,200	18

Any vessel that cannot make 18 knots an hour will in the future be next to worthless as a ship of war. Speed will be the great desideratum, and this is the object to which European navies are devoting their attention, with a view of competing with the transatlantic steamers, which in these days frequently average 18 knots an hour.

There is no reason why ships of war should not do as well, for they are seldom down to their load line, and their guns, ammunition, provisions, crew, &c., are not equal in dead weight to the cargoes of merchant steamers.

But these last-named vessels steam rapidly, because they have great horse-power and comparatively light engines of the best material and workmanship.

In this, then, lies the advantage of a first-class English merchant steamer over an American man-of-war. In the latter the machinery is so heavily built that with its weight and great friction is involved the question of cinematics, or loss of force, out of all proportion to the horse-power of a vessel.

It should be taken into consideration that a steel vessel of the largest class cannot be built in this country in less than two and a half years.

The case of the Chicago seems in point, for although authorized by the act of August 5, 1882, she is still on the stocks, and no man can tell when she will be finished. The Boston and Atlanta, authorized by the same act, are also unfinished.

This indicates a want of capacity on the part of the contractors to do the work, and it must appear that if hard pushed for vessels on the verge of war it would be next to impossible to supply promptly the needs of the Navy.

One great difficulty under which the Government labors is due to the fact that it has no complete building yard of its own wherein to construct ships of war at its pleasure and in a specified time. The navy-yard at Brooklyn, N. Y., is the only one fairly supplied with means to build a steel ship, and I am of opinion that at least one of the largest of the new vessels should be constructed there.

Those persons who are familiar with the difficulties encountered by the Navy Department during the civil war, in the attempt to obtain vessels from contractors at the time agreed upon, can realize what a benefit it would have been to the country had we possessed one first-class establishment for building steel ships, although ship-building in that material was then in its infancy.

Great efforts were made by the naval authorities at that time to induce Congress to appropriate money for the purchase of a proper site, for it was even then realized that a revolution was taking place in naval architecture, and that iron hulls must soon supersede those of wood.

Owing to the immense extent of coast that we had to blockade, the United States had to collect a large steam navy, and then we began to realize the necessity of a large building and repairing navy-yard.

It was very soon evident to the Navy Department that we could not depend upon our small naval establishments to build up a navy at short notice, and as no steps had been taken to establish the necessary machine-shops and foundries, we were thrown entirely into the hands of contractors, few of whom had the tools and machinery required to do the work called for by the exigencies of the times. Fortunately for us we were called upon to contend with an enemy far worse off than ourselves, with neither public nor private machine-shops of much account.

Had we been contending with a strong naval power we would feel to this day—perhaps for a century to come—the humiliation of having had our coasts and harbors occupied by the enemy and our seaboard cities laid under contribution to punish us for our temerity in going to war without any proper means of carrying on hostilities.

We met with great embarrassment during the civil war for want of a proper building-yard, but in case of a war within the next few years our embarrassment would be greater still, so great that we could stand very little chance against a great naval power.

We have navy-yards in abundance, but, with the exception of those at Boston, New York, and Norfolk, they are scarcely worthy the name. The New York and Boston yards might in a year or so be made ready to build two or three iron ships each, which is the extent of their capacity.

The city of Philadelphia presented to the Government the site for a navy-yard at League Island, which was supposed to possess all the requirements of a first-class building-yard, not only on account of its favorable position for the safe-keeping of ships and its inaccessibility to an enemy, but for the facilities it offers for obtaining coal, iron, steel, and everything else used in the construction and equipment of ships of war.

Philadelphia is a city of machine-shops of all kinds, where the most skillful mechanics and laborers can be obtained at short notice; and with all the advantages it offers, including the surrounding fresh water, League Island is the one available site for a great manufacturing establishment which should build our ships in the future.

League Island has already some semblance of a navy-yard, and possesses some forty or fifty acres reclaimed from the river, but it lacks nearly everything necessary for a national building establishment, and the site, instead of improving, is retrograding every day.

If we expect to maintain our position among nations, we must keep an adequate naval force in commission.

Some people say we want only a small but efficient navy, as if a small navy could be efficient. It is small enough now, one would think, to suit the wishes of its strongest opponents. It would be pitiful to see it grow any smaller.

We should, then, after carefully maturing our plans, go to work and build up the League Island navy-yard, and thereby make the Government independent of all outside shipbuilders.

At the same time I am in favor of giving to contractors the construction of a fair proportion of our ships, to enable them to keep up their plant to what would be required should we be obliged to build and equip a large navy in case of war. But our few private yards would be of little use in building up a navy rapidly, as all of them at present combined do not possess the appliances of a single first-class shipbuilding yard in Great Britain. It will be long before we possess any-

thing like the facilities that Great Britain has; where we could now build one ship she could build a hundred.

This must indicate that in spite of our boasted power we are in some respects a comparatively small nation.

There is good reason to believe that with proper facilities the United States Government could build ships as cheaply as contractors, for it is not to be supposed that the latter do business without the expectation of good profits.

The great advantage the Government will have in possessing a first-class ship-building yard is the regulation of the time in which it can build vessels.

This cannot be done by contractors, for up to the present time we have built too few ships to make it worth their while to enlarge their establishments.

After the necessity of building up a navy was conclusively demonstrated by the events of the civil war, we have gone on for twenty years without giving the contractors work enough to enable them to keep out of debt.

We have now a number of vessels, unfinished by the contractors, lying on our hands and forming a considerable navy, which bids fair to remain uncompleted for a long time to come.

If we should ever be forced into a war with a naval power, we must expect exactly similar measures used against ourselves as we used against the South during the civil war; and those who suffered by a blockade, that indispensable war measure, can now realize the necessity of being prepared for such a contingency, and providing a plant with which to build our own ships and machinery and manufacture our own guns.

At present our contractors are in no condition to build up an efficient navy, and with all the haste we can make it will probably be a quarter of a century before the Navy can be placed in proper condition to meet the wants of the nation.

All this matter was fully discussed twenty years ago, when the citizens of Philadelphia gave the Government a place for a great national ship-yard, but the project of utilizing the gift has apparently died of inanition, and the Navy is left in worse condition than it has ever been in since its reorganization after the war of the Revolution.

The Government then has a free gift of six hundred acres of land, with a depth of water sufficient for the largest vessels, presented with the tacit understanding that Congress would make of it the largest naval ship-building establishment in the world.

The faith of the Government has not been kept with those who might easily have realized a large amount of money by selling this valuable location.

If the time has arrived when we may hope to see a new navy arise from the ruins of the old one, I recommend that League Island navy-yard be built up on a scale commensurate with the wants of the nation. If we are ever to have a navy there is no better time than the present for commencing operations.

It is hardly possible that any rivalry should now exist among the different States in regard to the location of such a manufacturing yard, for it has been decided again and again by boards of officers that League Island is the best place for such an establishment, with the recommendation that if not used as originally intended it should, as an act of justice, revert to its generous donors, who in their patriotic desire for the advancement of the country sacrificed personal interests of considerable moment.

ORDNANCE OF SHIPS.

In examining the report of inspection of the U. S. S. Brooklyn, I notice that her battery, which in 1865 was 26 guns, has been reduced to 12 9-inch smooth bores, 1 8-inch muzzle-loading rifle, 1 60-pounder breech-loading rifle, 4 Hotchkiss revolving cannon, and 1 Gatling gun. This allowance should be increased by an addition to the number of Hotchkiss machine guns.

We are forced to recognize the fact that the batteries of all our ships are very inferior according to the present standard. The Dahlgren guns, with which our vessels are armed, have no superior as smooth-bores, but they are only available at close quarters.

If we could choose a position against an unarmored enemy and engage at close quarters, the effect of our spherical shells with large bursting charges would be very destructive; but our vessels are so wanting in speed that it would be impossible to close with an enemy against his will.

This would be our condition if contending with an enemy of what is called ordinary speed. Kept at long range, our men standing by r smooth-bore guns would be helplessly slaughtered. They could not return the enemy's fire, which they must receive with all the patience they can muster.

Until the Navy is provided with proper cannon it is necessary that some means be devised for supplementing the smooth-bore gun, and the readiest means at hand is to furnish to our ships a good supply of Hotchkiss guns, single-shot and revolving.

I understand that it is intended to provide the new cruisers with powerful secondary batteries, consisting of the most powerful Hotchkiss guns with large quantities of ammunition.

This is a very important step, but if the secondary battery is considered so necessary for ships that are to be armed with the latest pattern of rifled cannon, it is still more essential that Hotchkiss guns should be supplied to vessels which have only smooth-bore guns for their armament, with the additional disadvantage of a low rate of speed.

I therefore recommend that all our ships be provided with as many of these revolving guns as can be usefully mounted, and that a large amount of ammunition may be carried for them, storage for many other articles to be made to give way.

The 57 millimeter Hotchkiss single-shot rapid-firing gun throws a 6-pound projectile with a velocity of 2,000 feet per second. The shell has a fair bursting charge and will pierce 2 inches of iron at a distance of 1,000 yards. This is a powerful weapon, and even at long range may do much more injury to an enemy than a smooth-bore gun.

The 47-millimeter Hotchkiss single-shot rapid-firing gun is also a most useful weapon; can be readily handled in the tops of a ship and would serve as an efficient armament for cutters and boats.

The 37-millimeter gun is also efficient, and I understand that this weapon is to form part of the armament of the new cruisers; but I urge that it be at once furnished to every ship in commission, together with ample supply of ammunition.

As the manufacture of the new type of cannon is now fairly com-iced, I recommend that no more conversions of cast-iron smooth-bores be made. The converted guns are at best poor makeshifts, and st be thrown aside as soon as we have a sufficient number of steel rified guns to take their places. Every effort should be made to push forward the construction of the new guns.

The means now at the disposal of the chief of the Bureau of Ordnance are wholly inadequate. The length of time necessary to build a modern gun makes it essential to have many of them under construction at the same time; therefore prompt measures should be taken to place sufficient resources at the command of the chief of ordnance.

In this connection I would ask your particular attention to the report of the Gun-Foundry Board, which I consider presents a complete and satisfactory plan for action. The report was made by officers of the Army and Navy well qualified for the duty with which they were intrusted. I have yet to hear of any unfavorable criticisms on the report, which has found favor with Congress and the steel manufacturers of the country, and shows the way to establish the manufacture of steel in masses such as have heretofore been unknown in this country.

The plan set forth in detail by the Board will make us independent of foreign aid, as all the material will be provided by our own people; I consider the plan for the establishment of two gun foundries, one for the Army and the other for the Navy, as very judicious, and necessary to complete the work mapped out for the manufacturers. The members of the Board had the assistance of practical business men in making the recommendations embodied in the supplementary report. which provides a plan for immediate action.

As, in my judgment, the recommendations in the report of the Board embrace everything that is necessary in the premises, I recommend that Congress be urged to authorize the commencement of work on the basis therein indicated.

Nearly two years have been spent in the discussion of this matter. and now that the plan has been so fully explained and the project shown to be so necessary, it would seem that there is little more to be said on the subject.

COAST SURVEY.

The position of Superintendent of the Coast and Geodetic Survey has become vacant, and an opportunity is offered of organizing this branch of the public service on the only basis that will make it thoroughly efficient and enable it to perform what it was originally intended it should do, viz. furnish accurate charts and hydrographic information for the benefit of the Navy and the mercantile marine.

The very name, Coast Survey, implies that it should properly be under the supervision of the Navy Department and the work directed by a naval officer.

Some persons argue that the Coast Survey should be managed by "a purely scientific man of high attainments;" but it is much more desirable that it should be conducted by a person of administrative abilities, who could not only control the large naval element employed in this work, but could discipline the shore parties and obtain from them a proper amount of labor.

The Coast Survey originally extended only far enough back from the sea to establish primary and secondary triangulation stations, the secondary triangulation extending only about six miles from the coast-line. The topography was then put in with the plane-table and the entire work was essentially a survey of the coast for nautical purposes.

At the organization of the Survey much of the triangulation and topographical work and all the hydrography was performed by the Navy, and naval officers were employed at headquarters in the supervision of hydrographic work and in fitting out vessels manned by naval seamen.

Twelve vessels are at present employed in the Coast Survey, which are manned by 59 officers and 275 men of the Navy; the pay of the men amounting to $256,176 annually. The most important work of the Survey is performed by this force.

One of the best Superintendents of the Coast Survey was the late Mr. C. P. Patterson, who, with the necessary scientific knowledge, combined a fine executive ability and a knowledge of naval affairs which enabled him to thoroughly understand the management of the naval element and control the disbursement of money in that and all other departments.

There is no doubt that under Mr. Patterson's management a larger amount of work, mostly naval, was done than during the incumbency of any other superintendent for the same length of time, and he made it so apparent that the Coast Survey should be attached to the Navy Department that the late Secretary of the Navy strongly advocated the project.

There are a hundred good reasons why the Coast Survey should be a part of the Navy and not one against it. The duty must be more thoroughly performed and work would be carried on more systematically and economically than at present without materially changing the method now in vogue, and I feel satisfied that after a careful investigation of the subject you will be convinced that the way to make the Coast Survey most useful to the country will be to have it under naval management and attached to the Navy Department, even although a cry may be raised that no officer of the Navy possesses the necessary scientific knowledge to direct operations.

This objection was urged when Mr. Patterson, who had formerly been an officer in the Navy, was appointed Superintendent, but he soon demonstrated his ability to deal with the theoretical work, and at the same time placed himself far in advance of the methods of his predecessors, by the practical measures which he introduced.

At his death, Mr. Patterson left the Coast Survey so well regulated that it would almost run of itself, yet more than half of his life had been spent in the Navy, and the special knowledge that so well fitted him for the position of Superintendent was there obtained.

There is no reason why a similar training should not develop like capabilities in other naval officers.

Having myself served on the Coast Survey for a period of three years and being quite familiar with the system of operations, I nonot hesitate to give it as my opinion that the administrative ability of naval men will more than counterbalance any deficiency in theoretical science, if such deficiency should exist.

The power of maintaining discipline, a thorough knowledge of the objects of the Coast Survey, familiarity with hydrography, system in keeping accounts and records, and the absence of political or other bias to prevent inefficient persons being employed on the work, are all most important qualifications and they are more likely to be combined in a naval officer than in a civilian.

Moreover, the head of the Department under whom the Coast Survey was placed would become familiar with its details through the officer in command, who would naturally hold constant intercourse with his chief.

I affirm in good faith that a naval education peculiarly fits an officer for the Coast Survey. The main point is to administer affairs properly, and that depends very much upon the officer selected by the Department as superintendent, and I also assert that the coast survey can be

prosecuted by the Navy for a much less sum and in a more satisfactory manner than is the case at present.

I estimate the expenditures as one-third less than at present, as m temporary appointments now occupied by civilians must be filled by naval employés.

In view of all these considerations, I take the liberty of recommending the transfer of the Coast Survey to the Navy Department, and t an officer on the active list not below the grade of captain be appointed to superintend the work. I further recommend that the Geodetic vey be separated from the Coast Survey and transferred to the A .

I lately inspected the apprentice training-ship New Hampshire, Coaster's Harbor Island, Newport, R. I., and found her condition that could be desired. She is cleanly in all departments, and the boys are well disciplined, well instructed, and well fed. I wish I could add well clothed; but, owing to the boys being generally in debt for their outfit, and obliged to wear the Government canvas working suits, they become dissatisfied on the approach of winter with this uncomfortable-looking dress, and some have given that as a reason for deserting. Such causes of discontent should be eliminated, and in this insta the boys should be allowed a certain amount of money sufficient to supply each of them with two suits of clothes annually, this allowance to be continued after their transfer to a vessel of war.

Something is yet lacking to attach these boys to the Navy, although I do not know what it is. In the crew of the Brooklyn there were only six apprentices re-enlisted, which indicates that the boys do not continue in the service, certainly not in sufficient numbers to man our vessels with native-born seamen.

In the crew of the Brooklyn, exclusive of the marine guard, there were 244 persons, as follows:

Continuous service men	33
Men in service before	41
Native born (including apprentices)	106
Foreign born	133

Fortunately, at the present time we are enlisting a first-class set of foreign-born seamen—Swedes, Norwegians, and Danes—who are a great improvement on the generality of foreigners heretofore shipped in the Navy.

It is, however, desirable that our vessels of war should be manned by native-born seamen; but it seems unlikely that we shall succeed in this object until a fresh stimulus is given to our commercial marine.

The American sailor, like other people, is apt to go where he can command the highest wages, and the demand for his services is so great that he has no difficulty in getting good pay outside the Navy.

I have always asserted, and still maintain, that a cruiser to be an efficient vessel of war should have full sail-power, with masts so arranged that she could maneuver under sail sufficiently well to be able to tack and wear with the aid of one of her boilers.

A cruiser that is not provided with such sail-power cannot keep the sea for any length of time either in peace or war. She must stop frequently for coal, and, as I have noted in a previous report, "the powers of Europe in conference a few years ago declared coal to be contraband of war."

We have no colonies, and in case of war could not rely on obtaining coal at neutral ports, and vessels fitted with sail-power after the fashion of the Boston or Atlanta or even the Chicago, would not be able to get in or out of port after their coal was expended.

The persons who designed the above-named vessels must have known very little of the requirements of a cruiser. They might almost as well place a single stick in the middle of a ship and expect her to work under sail.

Our country is fruitful in experiments, but the notion of putting all the sail-power in the center of a ship, with a hybrid rig, would find no favor anywhere abroad, especially in vessels intended to cruise.

If men-of-war are intended only to grope along shore, they require no masts; a signal pole in the middle of a vessel being all-sufficient.

Any ship that we now possess, however old fashioned and wanting in speed, would make a better cruiser than either the Chicago, Boston, or Atlanta with the rig it is proposed to give them. No one of them could make any progress against a head wind, and this is true of every vessel fitted with such a hybrid rig.

No cruising ship, no matter what may be her size, should have less sail surface than five square feet to the ton. It does not follow that cruising vessels should be overweighted with masts and spars to enable them to carry sail.

When vessels were propelled by sail-power only, their masts and rigging were made heavy, as they depended on them to lie to in gales of wind and to claw off from a lee shore. With steam-power, vessels have no fear of lee shores, and in heavy gales can furl sail and lie to under eam.

But in making long voyages in time of war, vessels must have plenty of sail-power to carry them through favoring latitudes where it would be folly to waste their coal.

The masts of a steam vessel can be made much lighter than those of a sailing ship, and in case it is desired to steam against the wind all the spars except the lower masts can be on deck in half an hour, where they can offer no resistance to progress. All this a good sailor knows.

The Omaha, Capt. T. O. Selfridge, went lately under sail alone from New York to Gibraltar in 18 days. None of the hybrid rigs would ever get that far without using steam. The Omaha would, in fact, be a more efficient cruiser in time of war than any of the new vessels unless their rigs are changed.

It would be generally in moderate weather that cruisers would want to carry a great spread of sail, and under these circumstances their lighter masts would be sufficient for any amount of canvas. How ab- ırd it would be to see a ship of war steaming along with trade winds tnat would propel her ten or twelve knots an hour, provided she had proper sail-power!

The best cruiser we should have in time of war under present conditions is the Trenton, which vessel can make thirteen knots under steam, ıd with sail alone has been known to make as much; therefore it cannot be looked upon as an advance in the construction of steam ships of war to fit them with hybrid rigs.

It would be interesting and instructive to look over the account of coal burned in 1863 and 1864 by vessels that never made use of their sails. The cost ran up to the millions. It is easy to see that cruising ships without proper sail-power would be the most expensive vessels in the world.

No nation can afford such wasteful expenditures. The naval powers of Europe make all possible use of their sails, and the commanding officers of their ships have to account for every ton of coal they use.

I might write at great length on this subject and present further arguments against the proposed plan for crippling the cruising ships of

the Navy, but I will rest satisfied with the hope that the vessels will be fitted with sufficient sail-power to enable them to make eight knots on the wind and eleven knots off the wind.

To show how little has been done for our Navy in the past twenty years, I append an extract from one of my former reports which embodies some interesting facts:

Tabulated form showing the expenditures of foreign nations for the maintenance of their navies during the last fifteen years, as well as the amounts expended for the construction of new ships since 1865; also a statement of the expenditures by the United States for the same purposes during the same periods of time.

Countries.	Approximate expenditures for maintenance of the Navy, 1869 to 1884.	Expenditures for construction of new vessels, 1865–'84.
England	$805, 946, 430 00	$91, 000, 000 00
France	630, 000, 000 00	121, 000, 000 00
Russia	345, 000, 000 00	83, 583, 180 00
Italy	142, 500, 000 00	38, 000, 000 00
Sweden		14, 804, 689 00
Germany	144, 000, 000 00	26, 978, 731 00
United States	253, 796, 613 82	4, 907, 454 00

I beg leave to apologize to you for obtruding upon you so long a report.

I have the honor to be, very respectfully, your obedient servant,

DAVID D. PORTER,
Admiral.

Hon. WILLIAM C. WHITNEY,
Secretary of the Navy.

No. 13.—CONTRACTS FOR NEW STEEL CRUISERS.

The Naval Advisory Board to the Secretary of the Navy.

REPORT ON SECOND PRELIMINARY TRIAL OF THE DOLPHIN.

NAVAL ADVISORY BOARD, NAVY DEPARTMENT,
Washington City, March 17, 1885.

R: The Board has the honor to report that the preliminary trial of Dolphin has been made in accordance with the ninth clause of the tract for the construction of that vessel, concluded 23d July, 1883.

stated in our report of 24th November, 1884, the Dolphin was pre- ted for preliminary trial on 20th November last, and while on trial that date the thrust length of the steel shafting broke. A new rust shaft was made of forged steel, as recommended by the Board, d approved by the Department in letters dated 28th November. This t, after being manufactured under the inspection of the Board, and l in accordance with instructions approved by the Department on December, 1884, was rejected for the reasons stated in the Board's er to the Department of January 9, 1885. Then, in order to avoid de- , the Board recommended that this shaft be made of wrought iron, being then the intention to retain the other steel shafts, the tests for their examination having so far developed no flaws; subsequently, however, in the examination of the broken shaft, such extensive additional flaws were discovered in the center of its length, and as flaws were also found in drilling the end of the intermediate shaft, the Board decided that the intermediate and steel propeller-shafts should be removed and replaced by iron ones, under the conditions approved by the Department for the steel shafting of the cruisers in its letter to the Board of 15th January, 1885. This decision was approved by the Department, and the Dolphin's shafting, as tried on the 10th instant, consisted of the original built-up crank-shaft, forged from steel blooms, with cranks of wrought iron and steel crank-pins and three lengths of forged scrap-iron shafts 13½ inches in diameter. Certain changes in detail of the vessel have been made and completed, as approved by the Department since the first trial, all of which have tended to the increase of the efficiency of the vessel and contributed to the success of the trial, of which the results were, in detail, as follows:

The Dolphin, in charge of the contractor, Mr. John Roach, left the dock at the foot of Eighth street, on the East River, New York City, at 8.50 a. m., Tuesday, March 10, to make the preliminary trial in Long Island Sound.

The weather was clear; the thermometer showed 31° Fahrenheit; a stiff breeze blew all day from the NW., at the rate of about 30 miles an hour, according to the Signal-Office records; the tide was high at Ward's Island at 5.22 a. m.

The Dolphin's draught of water was 11 feet 7 inches forward, 14 feet 7 inches aft; 13 feet 1 inch mean; the displacement was 1,300 tons, or 200 tons less than the load displacement.

The degree of completeness, apart from the requirements of the contract, will be shown sufficiently by the following statement:

No armament, ammunition, provisions, or stores on board.

Whale-boat and large cutter at the davits.

Masts, spars, and rigging complete; no sails on board; water-tanks full, and about 120 tons of coal in the bunkers.

Anchors and chains on board.

The period of six consecutive hours, during which the engines were to be worked at full power, was begun when the buoy at Throg's Neck bore abeam at $9^h\ 58^m\ 4^s$ a. m. On passing Execution Rock Light, at $10^h\ 17^m\ 41^s$, a straight course was laid for the Middle Ground Light, nautical miles distant. The following is the full record of times observed when the objects bore abeam:

	Going east.	Going west.
	h. m. s.	h. m. s.
Passed Throg's Neck at full speed	9 58 04 a. m.	3 37 40 p. m.
Passed Execution Rock Light at full speed	10 17 41 a. m.	3 09 03 p. m.
Passed Matinicock Buoy at full speed	10 36 55 a. m.	....
Passed Eaton's Neck Light at full speed	11 20 05 a. m.	2 01 20 p. m.
Passed Middle Ground Light at full speed	12 15 02 p. m.	1 01 38 p. m.

At 12.35 p. m. the helm was put over 15° to return over the s course. After passing Execution Rock on the return, the helm was hard over and the vessel turned at full speed, the complete circle being made in 7 minutes and 6 seconds.

At $3^h\ 58^m$ p. m. the six hours expired; the vessel, going at full spe was off Riker's Island.

The speed of the vessel over the ground, as obtained from the distance by chart between Execution Rock and the Middle Ground Light, is 15.79 knots going east, and 14.53 going west, or a mean speed of 15.16 knots an hour. The record of speed is given merely for information, but is not regarded as a satisfactory measure of the vessel's perfor ance through the water, owing to the unknown effect of the wind and tide.

For the first part of the eastward run the sea was quite smooth. About 12 m. the wind shifted more to the west, and on the westward run the sea was unusually heavy for the Sound.

The performance of the machinery is shown by the following result of the observations in engine and boiler rooms:

	Average for six hours.	Maximum.
Revolution per minute	74.18	77
Boiler pressure in pounds per square inch	81.5	86
Vacuum in inches of mercury	25.1	26.5
Temperature in engine-room	71.8	75
Temperature in forward fire-room	72.9	86
Temperature in after fire-room	68.5	78

	Mean for six hours.
Indicated horse-power developed in high-pressure cylinder	1,040.29
Indicated horse-power developed in low-pressure cylinder	989.24
Total power developed by main engine	2,029.53
Total power developed by auxilary engines { Blowers / Pumps }	88.5
Mean collective horse-power developed	2,118.03
Maximum collective horse-power developed	2,278.60

The fuel used was the Welsh semi-bituminous coal, imported for the Greely relief expedition; the number of times that this coal has been trans-shipped has reduced the greater part of it to a fine powder, and therefore, the Board is of the opinion that with coal of the same or similar quality, but in better condition, the results would be improved. The fire-rooms were open and the draft was assisted by blowers.

The contract requires in regard to this trial that—

* * * * * * *

When the vessel is completed and ready for delivery, as required by the specifications, the same shall be subjected to a trial trip, under conditions prescribed by the Naval Advisory Board, and approved by the Secretary of the Navy, to test the machinery, engines, boilers, and appurtenances, and shall be accepted only on fulfillment of and subject to the conditions and agreements hereinafter set forth:

(1) That the working of said machinery in all its parts shall be to the satisfaction of the Naval Advisory Board.

(2) That the collective indicated horse-power developed by said engines under the prescribed conditions shall be two thousand three hundred (2,300), and maintained successfully for six (6) consecutive hours: *Provided*, That in case of the failure of the development of this power the vessel shall be accepted if it can be shown, to the satisfaction of the Naval Advisory Board and the Secretary of the Navy, that this failure was due neither to defective workmanship nor materials.

* * * * * * *

(10) If at and upon the trial trip before mentioned the hull and fittings are found by the Naval Advisory Board to be strong and well built, and in strict conformity with the contract, drawings, and specifications, the same shall be accepted, subject, however, to a reserve of eight thousand dollars ($8,000) from the reservations hereinafter set forth.

The trial was made as recommended by the Board in its letter to the Department of 11th September, 1884, and approved by the Department in its letter to the Board of 25th October.

The machinery in all its parts worked smoothly, continuously, and satisfactorily throughout the trial, and the Board is of the opinion that the deficiency of 182 horses power from mean of 2,300 required by the contract for six consecutive hours was not due to defective workmanship nor materials, but that with better coal and a well trained engineer's force these results will be exceeded.

According to the records of the Board, the total weight of the machinery, engines, boilers, and appurtenances and spare parts, completed as required, including water in surface condensers and boilers, does not exceed the limit of 430 tons set by the contract. The Board finds that the hull and fittings are strong and well built, and in strict conformity with the contract, drawings, and specifications, and that the vessel will be completed in all respects as required by the contract on the 18th instant, except the following minor items, namely: adjusting the Hotchkiss gun centers and fitting the sideboards for dishes, which can only be completed after the vessel is at the navy-yard.

The Board therefore recommends that the Dolphin be accepted, subject to the provisions of the ninth and tenth clauses of the contract, and orders issued to the contractor for her delivery to the commandant of the New York navy-yard, as already agreed upon, on the 18th instant.

The Board will forward approved bills for the final payments in accordance with the memorandum submitted to the Department, being in amount the tenth payment on the contract and the amounts due for changes and additions as approved by the Department, less the reservation of $8,000 to be withheld under the tenth clause of the contract,

and the amounts due the Government on approved changes in the inal plans.

Very respectfully,

E. SIMPSON,
Rear-Admiral, U. S. N., President of the Board.
HENRY STEERS,
Naval Architect.
ALEX. HENDERSON,
Chief Engineer, U. S. N.
J. A. HOWELL,
Captain, U. S. N.
F. M. BARBER,
Lieutenant-Commander, U. S. N.
F. L. FERNALD,
Naval Constructor, U. S. N.

Hon. W. C. WHITNEY,
Secretary of the Navy.

The Naval Advisory Board to the Secretary of the Navy.

INSTRUCTIONS FOR FITTING OUT THE DOLPHIN.

NAVAL ADVISORY BOARD, NAVY DEPARTMENT,
Washington City, March 17, 1885.

SIR: The Board respectfully suggests that instructions should be issued to the commandant of the New York navy-yard directing in fitting out the Dolphin a careful, complete record shall be kept of the weight of every article placed on board or removed from the vessel up to the time that she is reported ready for final trial, when it should be properly prepared and classified and forwarded to this Board.

Very respectfully,

E. SIMPSON,
Rear-Admiral, U. S. N., President of the Board.

Hon. W. C. WHITNEY,
Secretary of the Navy.

John Roach to the Secretary of the Navy.

MORGAN IRON WORKS,
New York, March 19, 1885.

SIR: I beg to inform you that the U. S. S. Dolphin has been completed in all respects in accordance with the specifications, and certificates from the inspectors of hull and machinery have been forwarded to the Naval Advisory Board to this effect.

I am now prepared to deliver the vessel to navy-yard, in accordance with the terms of my contract with the Department.

Will you please give instructions to the commandant of the yard directing him to receive the vessel?

Yours, respectfully,

ACH.

Hon. W. C. WHITNEY,
Secretary of the Navy, Wa

The Secretary of the Navy to John Roach.

NAVY DEPARTMENT,
Washington, March 20, 1885.

SIR: I have the honor to acknowledge the receipt of your letter of March 19, informing me that the U. S. S. Dolphin has been completed in all respects in accordance with the specifications, and certificates from the inspectors of hull and machinery have been forwarded to the Naval Advisory Board, to this effect, and that you are prepared now to deliver the vessel in accordance with the contract, and request me to give instructions to the commandant of the yard directing him to receive the vessel.

I have looked over the papers presented by the Advisory Board, and find that the vessel did not upon her trial trip recently show 2,300 collective indicated horse-power developed by her engines, and maintained successively for six consecutive hours, as contemplated by the contract. It is, however, provided in the contract that, notwithstanding this failure, the vessel shall be accepted "if it can be shown, to the satisfaction of the Naval Advisory Board, and the Secretary of the Navy, that this failure was due neither to defective workmanship nor materials."

The Board has expressed its opinion that the deficiency of 182 indicated horse-power required was not due to defective workmanship nor materials; but that with better coal and a well-trained engineers' force this result would be exceeded.

I would suggest that another trial be had, under such conditions as shall be prescribed by the Department, for the purpose of demonstrating that this supposition is correct. In this and other regards, I am now looking somewhat into the matter before exercising so grave a responsibility as accepting the vessel.

I desire a statement from you of the full amount of your claim upon the Dolphin up to date.

Very respectfully, yours,

W. C. WHITNEY,
Secretary of the Navy.

JOHN ROACH,
New York City.

The Secretary of the Navy to the Naval Advisory Board.

APRIL 7, 1885.

SIR: After examining the contract and laws relating to the construction of the Dolphin, I am of opinion that the act performed by me in passing upon the final payment and plans is not a formal act, but one with reference to which I seem to have responsibility.

I have neither the time nor the expert knowledge with which to possess myself of the necessary information upon which to base a judgment, and while if I had been present in the Department during the construction of the vessel I should doubtless be possessed of a matured opinion and judgment upon the subject, under the present circumstances that is quite impossible.

In view of the fact that my formal act is required in addition to the act of the Advisory Board, it is quite evident it was not intended that I should rely solely upon the action of the Advisory Board in this matter; otherwise, the action of the Secretary would not be required. I have,

consequently, decided to designate three persons, who have not been connected with the construction, for the purpose of assisting me in the discharge of the duty which, without such aid, it is quite impossible for me to perform.

I desire to notify your Board of my action, that it may not be construed to arise from any intention to reflect upon the correctness of the conclusion to which the Advisory Board has come.

Very respectfully, yours,

W. C. WHITNEY,
Secretary of the Navy.

Rear-Admiral EDWARD SIMPSON, U. S. N.,
President Naval Advisory Board.

The Secretary of the Navy to John Roach.

NAVY DEPARTMENT,
Washington, April 7, 1885.

SIR: I have your letter of April 4, stating that "the insurance of $285,000 on the Dolphin expires on the 9th instant, and cannot be renewed for less than thirty days, as the companies will not issue policies for a shorter period. Do you desire me to renew it?" In answer to which I would say that I have no request to make with reference to it except that until the steamship is accepted the contract provides that you shall keep her insured, which would seem to determine the matter.

I have no answer from you to my communication of March 20, in which I suggest that another trial trip of the Dolphin be held for the purpose of assisting in the determination of certain matters therein referred to.

Very respectfully, yours,

W. C. WHITNEY,
Secretary of the Navy.

JOHN ROACH, Esq.,
Morgan Iron Works, New York.

Instructions of the Secretary of the Navy to the Examining Board.

NAVY DEPARTMENT,
Washington, April 7, 1885.

The steamship Dolphin, built under contract between the Navy Department and Mr. John Roach, is presented for acceptance and final payment under her contract.

For the purpose of informing myself as far as possible of the facts necessary to the determination of the matter involved in her acceptance I hereby designate Capt. George E. Belknap and Commander Robley D. Evans to act with Mr. Herman Winter, of New York, as a Board of Examination to investigate and report to me—

1. Whether she has been constructed in accordance with the terms of the contract.

2. In view of the necessary limitations upon any investigation of a completed ship to report specifically what matters they are able to determine and how they determine them.

3. matters are impossible of determination except as the work ig on.

ine B l will be furnished such assistance, expert or otherwise, as sire, and has no responsibility for the success or failure of it accepted by me.

W. C. WHITNEY,
Secretary of the Navy.

NAVY DEPARTMENT,
Washington, April 30, 1885.

SIR: In addition to the instructions heretofore given you with re- l to the examination of the Dolphin, your Board will please re- t to me any defects which may attract your attention or which you ay discover in the present condition of the boat, whether due to her gn or plan, or to the execution thereof, specifying in detail her de- s, if any, so as to convey intelligible information as to the cause in h case.

Very respectfully,

W. C. WHITNEY,
Secretary of the Navy.

Capt. GEORGE E. BELKNAP, U. S. N.,
President Board, &c., New York City.

John Roach to the Secretary of the Navy.

MORGAN IRON WORKS,
New York, April 16, 1885.

SIR: I am in receipt of your letter of 15th inst., informing me of the pointment of a Board to make examination of the Dolphin, and beg say that I will, on their application, furnish them with every facility opportunity in my power for such examination as they may desire. Although it is customary to furnish the builders of vessels with a py of the final reports made relating to construction and performance, have as yet received no copy of the report of the Naval Advisory d in this case, nor have I any information regarding it except what nave seen in the newspapers.

Will you please furnish me with a copy of the same?

Yours, respectfully,

JOHN ROACH.

Hon. W. C. WHITNEY,
Secretary of the Navy, Washington, D. C.

John Roach to the Secretary of the Navy.

MORGAN IRON WORKS,
New York, April 30, 1885.

SIR: I hoped to have had an opportunity of seeing you while in New , but failed in my effort to do so. I wished to express my desire orm in every detail with the conditions of my contract for the

Dolphin and the cruisers and to comply with any reasonable suggestion or wish you might make, even if not explicitly specified in the contract. I also asked my friend, Mr. Vanderpoel, to see you and look over the Dolphin contract, thinking that together you might more easily c to some definite understanding as to how I could comply with your wishes. I have been, since the trial on the 10th of March, at the expense of wharfage, insurance, and ship-keepers, but have no info tion from you or the Advisory Board as to what, if anything further, is required of me.

Will it be convenient for you to see me on this subject and the other contracts, if I come to Washington in the next few days?

Yours, very respectfully,

JOHN ROACH.

Hon. W. C. WHITNEY,
Secretary of the Navy, Washington, D. C.

The Secretary of the Navy to John Roach.

MAY 2, 1885.

SIR: I have your letter of April 30, in which you state that you had hoped to have seen me in New York recently; that you wished to express your desire to conform in every detail with the conditions of y contract for the Dolphin and the cruisers, and to comply with any reasonable suggestion or wish I might make, even if not explicitly sp fied in the contract. The letter also states that you have asked y friend, Mr. Vanderpoel, to see me and look over the Dolphin c t thinking that together we might more easily come to some u ing as to how you could comply with my wishes. You state that you have been, since the trial on the 10th of March, at the expense of wl age, insurance, and ship-keepers, but have no information from or from the Advisory Board as to what, if anything further, is required of you. You ask whether it would be convenient for me to see you on subject and the other contracts if you come to Washington in the few days.

I will see you at any time that you make it convenient to come. I am somewhat surprised at the statement contained in this letter wh you say that "since the trial on the 10th of March you have no info tion from me or from the Advisory Board as to what, if anything ther, is required of you." On the 20th of March I received a letter fr you dated the 19th, informing me of the result of the trial trip of Dolphin, and requesting me to give instructions to the commandant of the navy-yard at New York to receive the vessel, stating that she been completed in accordance with the contract and was ready for delivery. On that same day I addressed you a letter, calling attention to the fact that in one respect, specifically mentioned, her performan upon the trial did not exhibit the result called for by the contract, in which case the contract provided that she should be accepted notwithstanding this defect "if it can be shown to the satisfaction of the Advisory Board and the *Secretary of the Navy* that this failure due neither to defective workmanship nor materials." In that c tion I said:

> I would suggest that another trial be had, under such conditions as shall be scribed by the Department.

I also stated in the letter:

In this and other regards I am now looking somewhat into the matter before exercising so grave a responsibility as accepting the vessel.

Up to the present time I have received no answer from you to the portion of that letter which suggests that another trial be held for my advisement. On the 7th of April I called your attention to this omission on your part in a letter as follows:

I have no answer from you to my communication of March 20, in which I suggest that another trial trip of the Dolphin be held for the purpose of assisting in the determination of certain matters therein referred to.

The contract provides "that it shall not, under any circumstances, be obligatory upon the party of the second part to accept the vessel or any part thereof to be constructed under this contract unless the same shall have been completed in strict conformity with this contract, under the supervision of the Naval Advisory Board, and in accordance with the provisions of the act of August 5, 1882, as modified by the act of March 3, 1883, hereinbefore referred to, and that this qualification shall be deemed and taken as applicable and applying to each and every clause, covenant, and condition, express or implied, in this contract contained."

A similar provision is found in the statute which authorized the con- ruction of the boat. It was plainly my duty to take such steps as ›m to me proper to ascertain whether the boat had been constructed strict conformity with the contract. To aid me in determining these ts, I designated three persons of eminent fitness for the purpose of co lucting an inquiry, which I personally had not the time nor the ex- knowledge to make; and on the 24th of April, as I am informed, y addressed you a communication requesting you to prepare the hin for a trial trip at sea at as early a date as possible.

I request an answer to these communications.

Very respectfully,

W. C. WHITNEY,
Secretary of the Navy.

JOHN ROACH, Esq.,
Morgan Iron Works, New York.

A. J. Vanderpoel to the Secretary of the Navy.

NEW YORK, *May* 5, 1885.

DEAR SIR: I have given to Mr. Roach the substance of our interview on Saturday last. I called his attention to the point that he had not replied to your letter. He said that he did not understand from the letter that it called for a reply except as to his claim, which I under- ood him to say was already in your office, and would be found there by reference to the papers; that he understood from your letter that you were to determine and advise him, after looking into the matter further, whether a further trial would be required. In the next to the ragraph of your letter you say, "I would suggest that another al had, under such conditions as shall be prescribed by the De- nt, for the purpose of demonstrating that this supposition was In this and other regards I am now looking somewhat into before exercising so grave a responsibility as accepting the

vessel," and Mr. Roach supposed that he would hear further from you in regard to it.

Mr. Roach has no recollection of having received your second letter. It was not brought to his attention at his office.

Mr. Roach himself will be in Washington in a day or two to confer with you.

Very respectfully, yours,

A. J. VANDERPOEL.

Hon. WILLIAM C. WHITNEY,
Secretary of the Navy.

The Secretary of the Navy to John Roach.

NAVY DEPARTMENT,
Washington, May 22, 1885.

SIR: You will, I think, recognize that the performances of the Dolphin thus far impose upon me the duty of exercising an unusual degree of caution in dealing with her. What would have been reasonable prudence in me some weeks since would not be so now. It is quite possible that the difficulties encountered in making her go through a trial trip may have been due to accident and temporary causes; but you would not now expect her to be accepted without your having an opportunity to demonstrate beyond all question the high character of her work. I understood you to assent to this proposition in our conversation yesterday, and while I do not understand you now to claim for her the speed nor the horse-power contemplated, you do insist that so far as your part is concerned, that the plans have been properly executed.

I have given orders, in accordance with our arrangement yesterday, for a further trial to be held, under similar conditions as the last, on Thursday, the 28th instant. In addition to this, I must ask that she be put to a similar run at sea upon such day as you may name. I do not insist upon her full horse-power or fifteen knots speed upon this latter trial, if deemed by you too trying upon her new machinery. A speed of twelve knots will answer the conditions under which I wish to place her. She should be loaded to something near her lines; and the expense of this latter trial will be borne by the Government in case she is accepted.

Very respectfully,

WILLIAM C. WHITNEY,
Secretary of the Navy.

JOHN ROACH, Esq., *Morgan Iron Works, New York.*

John Roach to the Secretary of the Navy.

MORGAN IRON WORKS,
New York, May 25, 1885.

SIR: Your letter of the 22d instant, relating to trial trips of the Dolphin, is duly received.

Although I consider—and it appears very plain under the terms of the contract—that my liability ceased and all conditions required of me were complied with on the termination of the trial of March 10, still

am very willing, as I have previously stated to you, to do all in my ower to satisfy you as to the efficiency of the ship so far as I am re- ısible under my contract. For this purpose the trial on Long Island und will be made on the 28th instant, as you direct, and the other at s early a day thereafter as practicable.

Yours, respectfully,

JOHN ROACH.

Hon. W. C. WHITNEY,
Secretary of the Navy, Washington, D. C.

John Roach to the Secretary of the Navy.

MORGAN IRON WORKS,
New York, June 8, 1885.

SIR: I have your telegram of this date, regarding insurance and dock- ing of Dolphin. I could not obtain insurance for the necessary amount in this country, covering all the risks of a trip at sea, and ordered it by cable from Liverpool, receiving cable reply that it had been effected. I will forward you to-morrow certificates of the agents here to that t. The companies are aware that she has been aground.

ı can arrange to dock the vessel on Wednesday, the 10th instant, or trial can be made on Thursday, 11th instant, and the vessel docked ıer return. I have no instruction as to the desired weight to be put ıer, which Captain Belknap said would probably be sent me, and ınich I could be preparing. I cannot see where I have neglected at- ion to these matters, as, from my last conversation with Captain knap, on May 29, I understood that I was to receive a message from ım when he could examine the vessel, and expected that this and the ip would have occurred last week, he suggesting Thursday as a con- enient day, and we were ready at that time.

I have been waiting for some days for authority to dock the Atlanta, put in shaft and propeller, having been advised by the Naval Ad- isory Board on the 1st instant that they had recommended that this done in order to paint bottom at same time. The work on this vessel eing delayed in consequence.

Yours, respectfully,

JOHN ROACH.

Hon. W. C. WHITNEY,
Secretary of the Navy, Washington, D. C.

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eport of the Examining Board on the trial and construction of the Dol- phin.

NEW YORK, N. Y., *June* 15, 1885.

SIR: I have the honor to forward by the hands of Commander R. D. ans, U. S. N., the report of the Board of Examination in the matter n the examination of the steam dispatch boat Dolphin, made in con- formity with the Department's order of the 7th April, 1885, and its sup- plementary instructions of April 30, 1885.

Very respectfully, your obedient servant,

GEO. E. BELKNAP,
Commodore, U. S. N., President of Board.

Hon. W. C. WHITNEY,
Secretary of the Navy, Washington, D. C.

NEW YORK, N. Y., *June* 15, 1885.

SIR: The Board of Examination constituted by the Department's order of the 7th April, 1885, a copy of which is herewith appended marked A, to investigate and make report as to the construction of the steam dispatch boat Dolphin, built under contract between the Navy Department and Mr. John Roach, has the honor to submit the follow report and addenda; and the Board understands that by the orders issued to it the report is to cover the following points:

(1.) Has the Dolphin been constructed in accordance with the terms of the contract between Mr. John Roach and the Government?

(2.) What defects, if any, whether of plan or execution, are apparent in the Dolphin from such examination as can now be made in her present completed state.

(3.) What matters can be determined and what matters are incapable of determination in a completed ship.

The difficulties attending the examination of a completed ship are many and manifest. Whether the structure conforms to the plans cannot in the main be ascertained after the ship is closed up. The character of the workmanship is to a large extent also concealed, and the quality of the steel, iron, and other materials used in the construction of the ship, her engines, machinery, and fixtures is impossible of ascertainment.

To examine the Dolphin so as to fully answer the above inquiries and to locate accurately the causes of the weakness observed in her would necessitate the expenditure of a very large sum of money in taking out the machinery and opening up of the ship. Wherefore such examination as this Board has felt authorized to make can only develop such defects as cannot be concealed.

The Dolphin is intended for a dispatch boat. She has, and was intended to have, very little offensive power. Reliable speed is therefore her first and greatest requisite for usefulness. She must be able to possess this quality in all weather and under all conditions at sea.

The law authorizing the construction of the Dolphin provided for a "sea speed" of 15 knots per hour. A dispatch boat not having the ability to make that speed continuously in such weather as she may reasonably be called upon to encounter, would at this day not answer the purposes of the service.

That a boat of her size should possess this requisite speed it is absolutely indispensable that she should have great strength and stiffness. That the Dolphin has not the requisite strength and stiffness to enable her to make the speed required under the conditions she must be prepared to meet, admits of no doubt, in the opinion of the Board.

The Board witnessed her performance on the smooth waters of Long Island Sound on three occasions. The conditions were most favorable, but the speed attained, making proper allowance for tidal influences, was not in excess of 15 knots per hour, a result very far from promising a like speed on the sea under the conditions she must always be ready to meet in actual service; for in order that a vessel should keep up a sea speed of 15 knots per hour she should be able to make from 17 to 17½ per knots per hour in smooth inland waters like the Sound.

On the occasions referred to the vibration of the Dolphin when subjected to only that duty and test was very perceptible, and of a character to demonstrate inadequate strength and stiffness. Under such circumstances the floors of the engine-room were observed to spring severely. And this, let it be noted, occurred when she was subjected to much less

ere duty than she must be expected to encounter when actually en-
ed in the service for which she was intended.

These facts, so obvious to the Board, needed no corroboration, but roboration was furnished on the second of the unsuccessful trial trips ed by the Board. On that occasion her after crank-pin became ter a short run—even before the actual trial had begun. This pin given no trouble on the previous trial, and the Board was informed the contractor and his men that it had never before given any ble. The only reason apparent for the trouble on this occasion, and e to which it was doubtless due, is to be found in the following s: On the previous unsuccessful trial about 40 tons of pig-iron had put in the forward part of the ship to trim her. Five tons more ere led on this occasion, and of course some portion of the coal had consumed from her bunkers. Even these slight changes in the uation of weights were seemingly sufficient to alter her shape so as to this after crank-pin to heat almost at once.

Wherefore the question arises, is this structural weakness due to a lt of plan or execution, or does it proceed from both?

In justice to the contractor it is proper to state that the plans exhib- to the Board and those furnished the contractor are very meagre, by no means provide for a vessel of adequate strength for the uses which the Dolphin was intended.

While it is clear that the plans are at fault, and if carried out in the manner would not produce a vessel of sufficient strength, yet it is to the Board that the Dolphin exhibits a degree of weakness in ess of what can properly be entirely attributed to the defective plans. Therefore the Board is of the opinion that the execution must be faulty his regard, but it is impossible to state with exactness the degree of e that might properly attach to the contractor in this precise re- ect without taking out the machinery and opening up the ship—a ork, as previously stated, involving a large expenditure of money.

The contract, among other things, provides that "provision be made closing the fire-room hatches and other openings sufficiently tight to intain an air pressure equivalent to a head of water of 1 inch in the e-room," and that the ship's engines shall in a trial trip of six hours cate 2,300 mean horse-power.

With regard to the first stipulation, no attention seems to have been ven for its proper observance, the contractor alleging that such press- e had been obtained on the first trial, witnessed by the Advisory rd, by using tarpaulins to cover the hatches, but owing to changes ade by the Board, with regard to the blowers, he could not now get pressure. It is only too evident that such an alleged contrivance but a makeshift at best, and could be of no practical value.

With regard to the stipulation as to horse-power, two unsuccessful npts to run the Dolphin in Long Island Sound for a period of six rs were witnessed by this Board. On the third trial the Dolphin eeded in running the required six hours, and she subsequently made fourth trial at sea from Sandy Hook to Barnegat Light and loaded to r sea displacement. The trip at sea, however, gave no test of her sea- g qualities, as the water was as smooth as had been previously d in the Sound.

On the first unsuccessful trip for the period she was running on the her engines indicated a mean collective horse-power of 2,088. On econd occasion her after crank-pin became heated, as previously d, before the actual trial began. On the third occasion her engines ated for the period of six hours a mean collective horse-power of

2,253; and on the fourth trial, the boilers making steam under natural draft alone, the horse-power developed by engines and pumps was 1,648.

On all these occasions great efforts were made by the contractor and his men to show the utmost power which could be developed. Her coal was of a superior quality, her engine and fire rooms in charge of regular engineers, and streams of water were kept playing on the journals to prevent heating; in short, her conditions in all respects were more favorable than those she can be expected to have when in service, especially when called upon to run day after day under the varying phases of wind, sea, and weather on the open ocean—the only test of real value in determining the qualities of a sea-going vessel.

With regard to the general workmanship found on board the Dol[illegible] the Board is of the opinion that it does not conform to the terms of contract and specifications in many particulars, as will be seen by erence to the appendix marked 1, annexed to this report, giving detail the proceedings and findings of the Board.

Since the Board began its detailed examination, the results of which are embodied in this report and its addenda, the contractor has been at work upon the vessel from time to time in remedying defects discovered by the Board, and the Dolphin is now in much better condition and appearance than when the Board first saw her, and in some important regards she is substantially improved.

For instance, she has been stiffened forward in the fore peak a[illegible] the hawse pipes by a vertical plate brace, a point where speci[illegible] ness was observed; in the after transom, where the reverse f[illegible] cut off, the cut frames have been connected by a floor plate; [illegible] deck and berth-deck have been calked fore and aft; the step of the m[illegible] mast, which was weak and insecure by reason of defective support, [illegible] been strengthened to a degree promising perfect security; the skin [illegible] the vessel has been repainted at various points where the skin was accessible; the hold store-rooms, fore and aft, have been freshly painted and fitted with proper shelving, and other things have been done in the direction of making the Dolphin a much better ship than the Board found her on its first inspection.

In submitting this their report the Board feels that it can go no fu[illegible] in the discharge of its duty under the instructions governing its act[illegible] and has to regret that so much as to the vessel's strength rests up[illegible] ion. Nothing short of a trial at sea for some time and in rou[illegible] can satisfactorily determine her actual strength or weakn[illegible] the absence of such trial or test—so much to be desired—[illegible] embodies the most that the Board has been able to ascertain, [illegible] vessel has recently been on a reef in the East River it is nece[illegible] she should be docked and her bottom examined. When this [illegible] the Board will submit the result of such examination.

It is proper to state here that Commander Evans, of the Board, did not witness the third trial of the vessel in Long Island Sound, having been unavoidably detained by his duties pertaining to the inspectorship of the fifth light-house district at the date of the trial.

Respectfully submitted by your obedient servants,

GEO. E. BELKNAP,
Commodore U. S. N., President of Board of Examination.

R. D. EVANS,
Commander U. S. N., Member.

HERMAN WINTER,
Constructing Engineer, Member.

Hon. W. C. WHITNEY,
Secretary of the Navy, Washington, D. C.

APPENDIX I.

Memoranda of examination and trials of the steam dispatch boat Dolphin, made and witnessed by the Board of Examination constituted by the Department's order of the 7th April, 1885, a copy of which is herewith appended, marked A.

In submitting this detailed report or memoranda, the Board has first to remark at there were many difficulties in the way of making a full and complete investigation of an already constructed ship; that "matters impossible of determination, except as the work is going on," embrace the quality of steel and iron and other materials used in the construction of the vessel, her agencies and dependencies, and all processes of building from the keel upwards; that the main part of the work and its character, whether good or bad, can only be determined by taking the vessel and her machinery apart; and that so many changes have been made in the plans and details of construction since the vessel was put under contract, so many authorized departures from the original specifications binding the contractor, that it has been well n impossible to get at all the facts desirable, as, for instance, when, on various occasions, the Board has found the work performed to be different from that called r by the specifications, the contractor or his representatives have alleged or explained that the change had been made by authority of the Advisory Board, both itten and verbal. To separate and distinguish clearly between the written and the alleged verbal authority given for the multiplicity of changes made, the Board has had no satisfactory means of doing, especially as regards the minor details of the vessel's construction and the seemingly authorized changes made in them.

The Board, after some delay in collecting the data necessary for its information, convened at New York on the 16th April, 1885, and was occupied more or less in the duties before it from that date until the 11th instant; and after careful examination of the vessel and trials under steam, together with all the facts obtainable with regard to the progress of her construction and the changes made from time to time in the original contract and specifications by authority of the Naval Advisory Board, find that, in its opinion, the vessel has not in all respects been constructed in accordance with the terms of the contract and specifications, in that, in various parts and particulars, "the materials and workmanship used and applied in the construction of the hull of said vessel, in details and finish," were not found to be "first-class and of the very best quality," as required and stipulated in said contract and its specifications.

And, to enumerate and specify as required by the Department's instructions, and as determined from the personal examination possible to make of a constructed ship, and by comparison with several recently-built steamships of the merchant marine, both foreign and domestic, to be found in this port, the Board further finds that, in its opinion, the steering apparatus is not "strong" nor "easy of adjustment," and is not in any way "protected from shot." The lead of the wheel ropes is bad, involving needless chafe at many points, and being exposed to the weather and constant wetting with sea-water throughout the length of the vessel from the stern to abreast the pilot-house, will be liable to speedy injury by rust. The 1-inch steel bolt connecting the wheel ropes to the chain round the quadrant on the rudder-head by a composition attachment will soon be so corroded by the action of salt water as to render it useless or unsafe for purposes of adjustment. The device for releasing the chains when changing from steam to hand power, and *vice versa*, is crude and difficult of manipulation, and much inferior to the arrangements for like purpose on board the best ships of the mercantile marine of the day. The wooden casing over the right and left hand screw steerer and the grating platform surrounding the wheel and apparatus are of weak and flimsy construction, and the after frame of the steerer is fitted to the stern upper works of the vessel in a very unworkmanlike manner. There is no way to ship the tiller, should such requirement arise, except by the removal of the hand-screw steerer from the rudder-head, together with its framing—a cumbersome detail at any time and a very grave matter to manage at sea in heavy weather. The tiller was not even on board ship, but the Board was told by one of the leading men or foremen of the works of the Messrs. Roach & Son that it was in the shop. The tiller was subsequently brought on board. The rudder indicator and ennunciator required for the after bridge and the ennunciator for the forward bridge are lacking. The after bridge is also unprovided with sounding or speaking tubes.

In the after transom three beams are unsupported by stanchions, rendering the deck above of doubtful strength to withstand the shock and strain of a heavy sea boarding the vessel at that point, a thing not unlikely to happen in scudding. In the same part of the hull two reverse frames are stopped short, and a space of about 4 inches separates them from the reverse frame, continuing to the deck-stringer above, thus weakening the frame at that important point.

The angle-iron truss forming support of mizzen-mast on port side is too light for

the purpose, and is also defective, having a split lengthwise in its web for a distance of about 6 inches.

The freeing ports amidships are so finished as to leave a water space of about 10 inches above the covering-plates forming the bottom of the hammock nettings. The port on the starboard side has the lower sill cemented on wood without any scupper or other arrangement for draining the water which in time will be likely to fill the space. The one on the port side was found to be uncemented, being simply closed with rough boards, but since the board noted such omission the cement has been put in.

The iron work of the vessel "where water may be liable to lodge," has not been cemented in all cases as required by the specifications, and the painting in some places has been neglected or slighted, as clearly shown by the rust observable on the metal.

The planking of the main deck is not of the "best quality," being knotty and shaky in parts, and not laid in the best manner, many of the wood screw bolts passing into the seams instead of into the body of the planks. The timber hatch coamings are too wide for good work and tightness, and the deck leaks fore and aft, as demonstrated by the rain-storm of the 1st ultimo.

Most of the coamings and hatches below the spar-deck, fore and aft the ship, are made in a rough and discreditable manner, patched with batten strips, and in no way conforming to the specifications calling for "workmanship of the most thorough character."

The planking of the berth deck is of inferior quality, rough and knotty in various parts, some places indicating sap, and calked in so poor a manner that the entire deck would leak like a sieve in case it became flooded with water, and so damage or destroy the perishable stores and equipments stowed below it in the hold, store-room, sail-room, bread-room, and the like. The Board was unable to find more than two thin threads of oakum in any of the seams, the specifications calling for not less than three threads , and it was an easy matter to pull the threads out by the yard in various parts of that deck. Some of the seams in the cabin did not seem to have been calked at all, and none of the seams of that part of the deck—cabin and ward-room—laid with white pine are painted, as required by the specifications. Such was the condition of the deck until the 11th ultimo, when the Board found a large gang of calkers on board at work on it. One effect of this calking, incomplete as it was, not extending into the wardroom, state-rooms, nor under bulkhead sills, was to make it difficult to shut down some of the hatches, to split or splinter to some extent the under side of the deck, and to start or drive out some of the wood-screw fastenings. its fastenings this deck shows grave defects; the wood-screw bolts pass into the seams instead of into the body of the planks at many points, and in the opinion of the Board the deck can never be calked in a proper manner. The butt plates, called for in the specifications to be placed under each butt of deck planking, have not, so far as the Board could discover, been supplied. In this connection attention is invited to the contractor's explanatory letter of May 11, 1885, a copy of which is herewith appended, marked "I."

The hold floors do not conform to the specifications, in that there are not sufficient arrangements for entering the bilges for cleaning and painting at all points of the ship.

The deck houses are not fitted with water-tight doors, nor the dispensary with bottle-racks; the galley-room and several of the hold store-rooms have no shelving; the seamen's water-closet lacks full cemented lining; the bread-room is not tinned throughout nor in a thorough manner, and lacks "perfect water-tightness," as shown by the water stains and rusted sheets of tin (one broken through) in its after part—all in default of the specifications. No gratings had been fitted in the bread-room, but have now been supplied.

The painting in the cabin and wardroom does not show "workmanship of the most thorough character:" it is inferior, and the gilded moldings called for in the specifications are lacking, as well as the tiling on the floor of the cabin bath-room and water-closet.

The bunk-boards in the state-rooms are fitted in a rough and careless manner, and some other of the joiner work in the cabin and wardroom, and wardroom companionway, cannot be considered, in minor details, as first-class work, especially as the bureaus in the state-rooms have no backs, the bulkheads being made to answer that purpose—a make-shift not known before to the naval service. The shutters do not seem strong enough to stand the hard usage of shipboard, and the state-room doors are not fitted with carrying rollers.

The wooden sheathing or ceiling of the sail-room is not carried up to the deck above to within 2 or 3 inches, leaving that space open for the access of vermin (rats) from the hold.

The bottom boards of the hammock nettings are about 3 inches below the [illegible] the scuppers, making it impossible to drain them pro[illegible] them, and the bottoms are not cemented. The [illegible]

first-class finish, especially the end or upright moldings, which are of soft pine, in the roughest manner. The top rails are not neatly scarfed in all cases, and ·d of the nettings on the port side a graving piece of soft pine set into the rail ts appearance.

water-tight covers on inner sides of hawse-pipes are roughly made and of in- ent strength. In some of the recently built merchant steamships the hawse- are fitted with neat water-tight plugs, which answer their purpose admirably.

sheathing of the chart-house deck is of inferior material and is not neatly laid.

o defects which may have been discovered by or have attracted the attention of ard, as suggested in the Department's supplementary instructions of the 30th , a copy of which is herewith appended, marked B, the Board is of the opinion he steering gear should have been arranged so as to have the wheel ropes lead the main deck and to carry a tiller as well as quadrant or circle at its appro- place in the after transom, and that the pilot-house should have been fitted oth steam and hand steering wheels, changeable from one to the other at a nt's notice, as provided on board merchant steamers of the best construction; r such purpose the house should have been arranged, and made larger if found ary. With the small steam steering wheel now in the house there is not suffi- room to get round the chart-table when working over a chart.

bow of the ship does not seem to be strong enough to resist the shock and re of the sea when butting into it in heavy weather; and to prevent possible g under such circumstances, double-angled stringers of the same size as the t upper and lower bilge keelsons should have been placed midway between the and lower decks from the inner part of the stem forging aft to the second col- bulkhead, with connecting intercostals making attachment to the skin of the s far as may be seen desirable, together with proper plate or angle breast-hooks n the collision compartment.

armory is badly located and cramped for room, in that it is put up on the berth- at the after end of the wing passage and imm diately adjacent to the steerage way, which from the closeness of the latter to the port gangway will be likely one of the wettest parts of the ship in bad weather. Seas coming over the ay would be almost sure to pour down that hatch, flooding the deck, including y and wing passage space below.

location of the dynamo, its engine, and switches of the electric-lighting appa- must be regarded as unfortunate, as, being placed on the berth-deck, they are to be tampered with by evil-disposed men of the crew, especially as the switch- has not been guarded with a protection frame. In the opinion of the board, the nd of the engine-room house might have been extended a little farther aft on the eck, so as to accommodate the apparatus without adding excessive weight to art of the ship. So located, the apparatus would have been under the eye of icer of the deck at all times, and more space been left for the crew on the rather ed quarters of the berth-deck.

large house over the cabin companion-way is a needless incumbrance, adding t to the ship, which could have been utilized to more efficient use elsewhere. It kes up room better left for the work of the deck and the range of sight from art of the vessel.

present carriage of the boats just abaft the gangway is not good; for sea- ge fittings should have been provided to carry them upon the rail or on light rs-frames.

construction is also defective in not finishing the berth-deck with water-ways uppers, the evidence of water collecting along the edges of the planking and eads being already too apparent, as shown in the wing passage on berth-deck nder steerage hatch.

void false closure of the water-tight doors, the door clamps should have been with stops to prevent their excessive action in passing beyond the point needed ctively close the doors.

he matter of the battery, the construction of the vessel in not providing for a rectly ahead with the 6-inch rifle must be regarded as a grave defect. Carry- t one effective gun, the greatest all-round range of fire possible should have rranged for.

pin rails have not been bored for belaying-pins, and the awning stanchions are vanized.

ends of the planking on the berth and top-gallant forecastle decks are not l at the ends of the vessel, as they ought to be to insure good work and strength.

h regard to the engines, boilers, and main machinery of the vessel, the Board, as it has been able to determine from the examination possible to make under n tances, is of the opinion that their general construction and the character terial of which they are made conforms to the terms of the contract and ons and the various changes made by authority of the Naval Advisory

Board from time to time. But the Board submits that the examination shows some omissions and defects that require noting, as follows:

The engine bed-plate was designed to be supported on a wooden bed laid between the engine foundation and bed-plate, through which bolting passes for securing them together. Each bolt was to be fitted with an iron filler in lieu of the wood to make solid bolting, but the examination showed that some of the bolts lack such appliances, leaving to the wood alone the strain imposed by the working of the engines, the ultimate effect of which would tend to the loosening of the main connection and support.

The supports to the shaft alley are not first class in workmanship, the angles and brackets not being properly cut to fit down on the frame of the vessel so as to give the best support.

The engine-room floors cannot be regarded as of first-class workmanship and necessary convenience.

The steel shafting called for in the contract broke on the first trial trip proper of the vessel. The contractor furnished another shaft of the same material, constructed under the same faulty process as the first one, but the tests applied to this new shaft not being satisfactory to the Advisory Board, the contractor was permitted to substitute iron shafting in its stead; and it would seem that the extra expense involved in the change, including the tests applied to the rejected shafting, and which further determined the action of the Advisory Board with regard to the shafting of the Atlanta, Boston, and Chicago, the removal of the prior shafting and the putting in of the iron one, together with the cost of the neccessary cutting away of the beams and planking on the berth and main decks and the enlargement of the stern and other bearings to take the larger diameter of the iron shaft, has been charged to the account of the Dolphin and against the Government. The Board is of the opinion that good and safe steel shafting, slightly modified from the specifications and drawings furnished the contractor, of the diameter required (13 inches), could have been made in this country, and that the cost of all shafting supplied the vessel, together with the incidental expenses connected with the removal of the broken shaft and the putting in of the new one, should have been borne by the contractor.

A compartment pump supplied to the vessel proved to be larger than was necessary. This pump was removed to be used in the Chicago, and a second and smaller one was put in in its stead, the cost of which was charged to the Dolphin. No cr[edit] seems to have been given the vessel for the pump removed.

On the 24th ultimo a letter was addressed to Mr. Roach, the contractor, a copy of which is herewith appended, marked C, requesting him to prepare the Dolphin for a trial trip at sea, to which Mr. Roach replied by letter under date of the 29th ultimo, a copy of which is herewith appended, marked D.

Nothing more definite or satisfactory was heard from Mr. Roach until the morning of the 6th instant, when, meeting the Board on board the Dolphin, he remarked t[hat] he had just returned from Washington and exhibited a copy of the Departme[nt's] orders to the Board of the 5th instant concerning the proposed trial trip.

Upon receipt of the Department's order in question, a copy of which is herew[ith] appended, marked E, Mr. Roach was addressed, as per copies of letters marke[d F] and G, and Rear Admiral E. Simpson, U. S. N., president of the Naval Advisory Board, was advised with regard to the matter, as per copy of letter marked H; and, in accordance with the arrangements indicated, the Board met on board the Dolphin on the morning of the 12th instant to witness the proposed trial down Long Island Sound, the run to be for six consecutive hours.

Chief Engineers Kierstead, Thomson, and Ziegler, U. S. N., accompanied the Board as experts to assist in determining the horse-power of the vessel. Lieut. T. C. McLean, U. S. N., also reported on board and was assigned to the duty of keeping the run of the vessel by patent log, and chart, and bearings. Of the Advisory Board only Mr. Henry Steers was present.

The Dolphin, in charge of a captain and pilot furnished by the contractor, the latter himself being on board, backed out from the dock at the foot of Eighth street, East River, at 9.10 a. m., and three minutes later proceeded up East River at good speed for the Sound. Execution Rock Light was reached at $10^h 38^m 52^s$ a. m., from which point departure was taken and the trial begun, the intention being to make a straight continuous run for the whole time and distance through the Sound.

The conditions of wind, sea, and tide were very favorable; the wind from point of departure of force from 1 to 2 from the southward and eastward to northward and eastward; the water smooth and of low temperature, and the tide at ebb, favoring the vessel at from one-half knot to 1 knot an hour. The barometer (aneroid) stood at 30.29; thermometer, 55. Draught of water forward, 12′ 0″; aft, 14′ 3″; mean, 13′ 1½″.

The draft in the furnaces was good, all the blowers running at high velocities, and the fuel used was George's Creek coal of excellent quality, clean, and burning with clear flame.

Eaton's Neck Point Light was passed at $11^h 42^m 51^s$ a. m., the vessel running at about

maximum speed. At 12h23m52s p. m., when nearing the Middle Ground Light, the engines gave the first indication of trouble, and at 12.25 p. m. slowed down considerably, coming to a dead stop at 12.30 p. m., thus ending the trial.

The forward crank-pin had become heated and it became necessary to make temporary repairs to get back to the dock, which operation occupied 4 hours 51 minutes, when the vessel was started back for New York, arriving at the foot of Twenty-eighth street at 8.40 p. m.

The speed made by the vessel could only be determined with approximate accuracy on that part of the course between Execution Rock and Eaton Neck Light, and was as follows, as shown by bearings and patent log:

Speed per hour by taffrail log	14.5
Speed per hour by bearings	15.5
Difference	1.0

But the difference in favor of the distance run per hour as shown by bearing can readily be accounted for by the effect of the fair tide, so that the speed registered by the taffrail log doubtless indicated the approximate speed given the vessel by the power of the engines for the first hour of the run, during which hour, however, the engines were not worked up to their highest point of effort.

The average speed for the entire run, but not possible to determine with the approximate accuracy obtainable with regard to the result shown during the first hour's work, was 14.8 knots per hour nearly.

The taffrail patent log used was a new one of the American pattern, furnished from the navy-yard, and there is no good reason to question its approximately correct registration.

The mean indicated horse-power developed by this partial trial averaged for both high and low pressure cylinders	1,998
By blowers and pumps, approximately	90
Mean collective power	2,088
The highest number of revolutions per minute	78
The lowest number of revolutions per minute	68
Highest pressure of steam ... pounds..	87½

This data was determined by the experts ordered to assist the Board, and as all the conditions of the trial were so exceptionally favorable for the vessel, the Board is constrained to believe that her engines will never develop the power for six consecutive hours called for in the contract.

No arrangements were apparent for securing the air pressure in the fire-rooms as required by the terms of the contract, *i. e.*, "an air pressure equivalent to a head of water of 1 inch in the fire-rooms," and when the contractor's attention was called to that point he stated that such pressure had been obtained on the first trial of the ship witnessed by the Advisory Board, by covering the hatches with tarpaulins, but owing to changes made by the Advisory Board he could not now get the pressure. It is needless to say that the air pressure demanded by the contract could not be obtained by any such contrivance as the contractor alleges was used on the occasion of the first trial witnessed by the Advisory Board. On this provision of the contract the efficiency and safety of the vessel might depend in a great degree in cases of emergency.

The vibrations of the ship during the run were of such a nature as to indicate a lack of structural stiffness, which, in the opinion of the Board, will be likely to rack and weaken the ship, especially under full power in a seaway. The floors forming the engine-room foundations spring severely, even when running under ordinary power in smooth water, and, in the opinion of the Board, additional stiffness should be provided under the engines and intermediate between them and the after bulkhead of engine-room, in the way of webbed frames forming cross floors extending up to the lower deck stringers, and from this by suitable proportions to shape for passage-way to extend to main-deck stringers.

The working of the steam steering-engine caused a severe vibration of the after part of the vessel, due, in the opinion of the Board, to the unusual character of the steering apparatus applied for a naval vessel.

Report of this partial trial having been made to the Department, the Board was directed to continue the trial when ready, and arrangements were made with Mr. Roach to proceed with the next trial on Monday, May 18, at which date the Board met again on board the Dolphin for the purpose in question, and accompanied by the same officers as on the previous occasion, with the exception of Chief Engineer Ziegler, whose place had been taken by Passed Assistant Engineer Kearney. Mr. Henry Steers was also present again to represent the Advisory Board. At 8.13 a. m. the ship backed out from the wharf in charge of the contractor, and at 8.25 a. m. started ahead from abreast the foot of Twenty-third street at moderate speed. At 9.19, when within about a mile of Execution Rock Light, from which point the trial was to begin, the after crank-pin became hot, and the vessel had to stop, and finally came to anchor.

And here one great defect in the ship's steam working gear became but too apparent, for while the vessel has twenty-three separate engines on board, no provision has been made for turning the engines by steam power when the main engines are disabled, and, instead of the less than five minutes that ought to have sufficed for the turning of the engines into position to enable the crank-pin and brasses to be overhauled, it took one hour and a half to effect that purpose, although only a quarter of a turn of the engines was required and made.

The ship was not ready to proceed under steam again until 5.05 p. m., when the anchor was weighed and a course laid past Execution Rock to the northward and eastward until 6.16 p. m.; the vessel was then turned back, and at 8.18 p. m. brought to anchor for the night off the foot of Twenty-eighth street.

In weighing the anchor the Board noticed that when a swivel of the chain reached the barrel of the steam windlass the grip was not good, and that recourse was had to a preventer rope before the swivel could be made to bite and pass abaft the barrel. Such defect would be likely to prove a serious matter in lifting the anchor in rough water; the slipping and surging of the chain under such conditions would be apt to snap it.

The conditions of this attempted trial were all favorable—good breeze for draught, smooth sea, excellent coal, the best lubricant (cold pressed castor oil), and a well-skilled force of engineers and firemen to manage the engines and boilers. Each fire-room was in charge of the contractor's leading workmen—regularly certificated chief engineers of the merchant marine—and the engines were attended by the most trusty and competent machinists and engineers of the contractor's establishment. In short, no effort or precaution was spared on the part of the contractor to make the engines and dependencies do their desired work; but the 40 tons of pig-iron ballast, placed in the forward end of the ship on the trial of the 12th instant, and the 5 tons more of like ballast put on board in the same part of the vessel on the occasion of this second attempt, together with the lessened weight amidships in the amount of coal consumed from the bunkers in the running of the engines for many hours alongside the dock, as well as in the river and sound before the trials could be carried out, may have had something to do with the failure of the machinery to work properly. If such be the fact, it indicates nothing less than structural weakness of the vessel, confirmatory of the impressions of the Board as expressed in another part of this report.

And here the Board takes occasion to express the opinion that the engines and machinery generally are of such inconvenient design and so inconveniently located and arranged as to require much more than the usual number of engine and fire-room force to properly attend them. In fact, the force needed will doubtless be as large for this little ship as is required to care for the engines and dependencies of much larger vessels of the naval service.

After nightfall the Board had opportunity to observe the working of the electric lighting apparatus, when it became apparent that its machinery is cramped for room, and that no provision has been made to protect the machinist in charge from accident when the ship is laboring in a seaway.

A rod or rail should be put up parallel with the machinery to afford such absolutely necessary safeguard, for, as now arranged, there is no point in the room which the machinist could take hold of to prevent being thrown upon the rapidly moving engines by the rolling, lurching, and pitching motion of the vessel incident to service at sea. The Board also noticed two or three gallons of oily water swashing about the deck of the room with no means of carrying it off. The deck should be leaded and fitted with coamings, and provided with scupper to run the water into the bilge.

On the afternoon after this last attempted trial Mr. Roach, the contractor, called upon the Board and requested information as to future procedure with regard to the vessel, and was referred to the Department, the Board having no authority to arrange for other trials without further instructions. Subsequently the Board received instructions from the Department to witness another trial in the Sound on the 28th ultimo, and on that date the ship left the dock in the East River for its third effort before the Board, on which occasion the ship's draught, with 230 tons of coal in the bunkers, was, aft, 15 feet 5 inches; forward, 12 feet 2 inches; mean, 13 feet 9½ inches.

	h.	m.	s.	
Backed out from wharf at	9	29		a. m.
Took departure from Execution Rock Light	11	02	38	a. m.
Passed Matinicock buoy	11	23	48	a. m.
Passed Eaton's Neck Light	12	10	06	p. m.
Passed Middle Ground	1	07	32	p. m.
Turned at Faulkner's Island	2	34	00	p. m.
Slowed from 75 to 74 turns in turning.				
Passed Middle Ground Light	4	14	21	p. m.
Six hours ended	5	02	38	p. m.

Wind from E. NE. to S. SE. during trial; force, 2 to
Barometer, 30.21. Thermometer attached. 64°
Anchored off foot Twenty-eighth

steam pressure	pounds	89
steam pressure	do	84
vacuum	inches	26¼
vacuum	do	24
feed temperature	degrees	120
feed temperature	do	106
number of revolutions		76
number of revolutions		72
horse-power by card		2,255
nate mean indicated collective horse-power		2,160.46
speed as shown by bearings	knots	14.93
ected for tide	do	14.6

nditions favorable; ebb tide, moderate breeze to light, smooth sea, and clear

eeper than on other trials and showed less vibration.
notion defective in still having too much jar.
is of water were pouring on the journals and crank-pins during the trial, and
mount of oil was consumed in lubricating the machinery.
oard found that shelving had been placed in the various store-rooms below;
od deal of the iron-work had been freshly painted, the step of the mizzen-
engthened, and preparations going on to splice the two out frames in transom.
ander Evans, of the Board, was not present, being unavoidably absent on
ty.
eers and Assistant Constructor Bowles represented the Advisory Board. Chief
s Kierstead and Thomson and Passed Assistant Engineers Perry and Kear-
e on board to take data with regard to horse-power, &c., and Lieutenant
kept the run of the log and chart for distances. Mr. Roach, the contractor,
on board.
Engineer Morley, U. S. N., submitted the following memorandum concerning
nding of the Dolphin on the 26th instant, when the contractor took the ves-
or a non-official trial:
backed out from the wharf at 5.45 a. m. Tide running flood and within about
and a half of high water. Ship was started ahead in channel while over reef;
ightly, when engines were stopped. Ship was then drifting along the reef,
e up the river. Struck quite heavily again and dragged along reef, the ves-
ning to starboard about 30°. The engines had been started slowly while on
while drifting, but screw struck and engines were stopped. Ship finally
fast on reef off Tenth street, aground under cabin; 14 feet of water under
d quarter, 18 feet under port quarter. Floated off by the tide and aid of tug
m."
w of the facts given in the foregoing memoranda, it would seem that the ves-
d be docked before the proposed sea trial is made, and to prepare her for such
her boats should be carried, her sails bent, and sufficient weight put on board
ent her service outfit and crew.
oach, the contractor, stated to the Board that he was ready and willing to put
in condition to make her satisfactory to the Government, no matter what
nse.
11th instant the fourth and last trial witnessed by the Board was had at sea
Sandy Hook, the ship having her sails bent, the boats hung to her davits, and
placed in various parts of the hold and on deck to represent her armament,
nd service equipment generally.
draught with bunkers full of coal and loaded with weights to represent serv-
acement:

	ft.	in.
	13	9
	15	3
	14	6

	h.	m.	s.	
from foot of Eighth street about	9	12	00	a. m.
parture from Scotland Light-ship	10	47	30	a. m.
t Light abeam, distant about 3 miles	1	57	15	p. m.
eam again after turning	2	01	00	p. m.
s' run ended	4	47	30	p. m.
cotland Light-ship	4	49	15	p. m.

eter, 30.41. Thermometer attached, 65°.
south to east. Force, 2 to 3.
the Despatch off Fort Richmond.
ival at Barnegat the Despatch was some 10 or 12 miles astern.

Highest steam pressure	pounds..	[illegible]
Lowest steam pressure	do....	[illegible]
Highest vacuum	inches..	27
Lowest vacuum	do....	25
Higest feed temperature	degrees..	[illegible]
Lowest feed temperature	do....	94
Highest number of revolutions		72
Lowest number of revolutions		64
Average number of revolutions		66.7[illegible]
Highest horse-power by card		1,9[illegible]
Approximate mean indicated horse-power independently of auxiliaries		1,6[illegible]
Approximate speed shown by bearings and influenced by fair tide	knots..	13.6

All conditions favorable for trial. Smooth sea, light breeze, and fair tide both ways, and in no sense could the trial be regarded as testing the seagoing qualities of the ship.

The fires were managed under natural draft.

The contractor and all the members of the Board were present, as well as Lieut. T. C. McLean, Chief Engineers Kierstead and Thomson, and Past Assistant Engineers Kearnay and Perry, also Mr. Samuel Archbold, Mr. Henry Steers and Assistant Constructors Bowles and Gatewood, of the Naval Advisory Board, and Assistant Constructor Hanscom.

Link motion still defective.

Water was run upon the journals and crank-pins, and oil very freely used throughout the trial.

Considerable vibration still apparent.

The lubricant was olive oil.

It was found that since the last trial in the Sound the spar-deck had been calked fore and aft, the calking on the berth deck finished, the cut frames in the transom connected by stout floor-plate, the painting of the skin and frames in that part of the ship finished, as well as in the fore peak, and that all the wood work in the hold storerooms had been given a fresh coat of white paint, and the masts scraped and the weather cracks filled up with putty.

A.

NAVY DEPARTMENT, *Washington, April 7*, 1885.

The steamship Dolphin, built under contract between the Navy Department and Mr. John Roach, is presented for acceptance and final payment under her contract.

For the purpose of informing myself as far as possible of the facts necessary to the determination of the matter involved in her acceptance, I hereby designate Capt. George E. Belknap and Commander Robley D. Evans to act with Mr. Herman Winter, of New York, as a board of examination to investigate and report to me—

1. Whether she has been constructed in accordance with the terms of the contract.

2. In view of the necessary limitations upon any investigation of a completed ship to report specifically what matters they are able to determine and how they determine them.

3. What matters are impossible of determination except as the work is going on.

The Board will be furnished such assistance, expert or otherwise, as they may desire, and has no responsibility for the success or failure of the ship if accepted by me.

W. C. WHITNEY,
Secretary of the Navy.

B.

NAVY DEPARTMENT, *Washington, April 30*, 1885.

SIR: In addition to the instructions heretofore given you with regard to the examination of the Dolphin, your Board will please report to me any defects which may attract your attention or which you may discover in the present condition of the boat, whether due to her design or plan, or to the execution thereof, specifying in detail her defects, if any, so as to convey intelligible information as to the cause in each case.

Very respectfully,

W. C. WHITNEY,
Secretary of the Navy.

Capt. GEORGE E. BELKNAP, U. S. N.,
President Board, &c., New York City.

C.

NEW YORK CITY, *April* 24, 1885.

SIR: For the fuller information of the Board of Examination acting under the instructions of the honorable Secretary of the Navy, the Board has to request you to prepare the Dolphin for a trial trip at sea at as early a date as possible.

Respectfully, your obedient servant,

GEO. E. BELKNAP,
Captain, U. S. N., Senior Member of Board.

Mr. JOHN ROACH,
New York City.

D.

[Morgan Iron Works, foot Ninth street, East River.]

NEW YORK, *April* 29, 1885.

SIR: Your letter of 24th instant received, in which you say: "Acting under the instructions of the honorable Secretary of the Navy, the Board has to request you to prepare the Dolphin for a trial trip at sea at as early a date as possible." The Dolphin, so far as I know, requires no preparation for such a trial, excepting the necessary supply of coal and men. Having already made the trial provided for in my contract with the Navy Department, the engines performing satisfactorily, as reported by the Naval Advisory Board, I will communicate direct with the honorable Secretary of the Navy regarding the additional trial suggested.

Your address not being given in your letter, and not being aware until to-day that you were in Washington, I have been unable to forward my reply.

Yours, very respectfully,

JOHN ROACH.

Capt. GEORGE E. BELKNAP, U. S. N.,
Washington, D. C.

E.

NAVY DEPARTMENT, *Washington, May* 5, 1885.

SIR: I have been called upon to-day by Mr. Roach. I have assented that the trial trip shall take place in the Sound instead of at sea, the Advisory Board to be present, but the directions to be given by your Board. With these conditions she will be ready for trial within one week, the same to be for a six hours' run.

Very respectfully,

W. C. WHITNEY,
Secretary of the Navy.

Capt. GEORGE E. BELKNAP, U. S. N.,
President Board, &c., New York City.

F.

MILLS BUILDING, FLOOR 8,
New York, May 6, 1885.

SIR: The Board of Examination is advised by the honorable Secretary of the Navy, under date of the 5th instant, that the Dolphin will be ready for a six hours' trial in Long Island Sound within a week from that date, and I beg to inform you that the Board will be ready to meet you on board the Dolphin in readiness to make the trial in question on Tuesday, the 12th instant, at 9 o'clock a. m.

The Board is also advised that the Naval Advisory Board will be present on the occasion of the trial.

Respectfully, your obedient servant,

GEO. E. BELKNAP,
Captain, U. S. N., Senior Member of Board.

Mr. JOHN ROACH,
New York City.

G.

NEW YORK, *May* 6, 1885.

SIR: Referring to my letter of this date concerning the trial trip of the Dolphin on Tuesday next, the Board is of the opinion that the fuel used should be the semi-bituminous coal with which our ships are generally supplied, especially on foreign service.

Respectfully, your obedient servant,

GEO. E. BELKNAP,
Captain, U. S. N., Senior Member of Board.

MR. JOHN ROACH,
New York, N. Y.

H.

MILLS BUILDING, FLOOR 8, ROOM 19,
New York City, May 7, 1885.

SIR: I have the honor to inclose for your information a copy of a letter of instructions from the Department concerning another trial trip of the steamship Dolphin, and beg to advise you that Mr. Roach, the contractor, has been informed that the Board of Examination will be on board that vessel in readiness for the trial in question on Tuesday next, the 12th instant, at 9 o'clock a. m.

Very respectfully, your obedient servant,

GEO. E. BELKNAP,
Captain, U. S. N., Senior Member of Board.

Rear-Admiral E. SIMPSON, U. S. N.,
President Naval Advisory Board, Washington, D. C.

I.

MORGAN IRON WORKS, FOOT NINTH STREET, EAST RIVER,
New York, May 11, 1885.

SIR: I desire to submit to your Board the accompanying blue prints of original plans of Dolphin, and to offer the following explanation of the details of construction wherein exceptions have been taken, viz: The reverse frame No. 130 was cut in contemplation of extending the berth-deck flat to the post, the reverse bars being required to be cut for this purpose. Subsequently it was decided to end this flat on bulkhead No. 128. Stanchions abaft this point to main-deck were not required by the plans or inspector, but were put elsewhere wherever directed, including six additional ones to main deck forward. The plates called for by specifications under butts of berth-deck plank were omitted at the discretion of inspector, the butts being cut diagonally to admit of fastening in each plank end. I find throughout the berth-decks forward and aft there are fourteen butts such as are referred to, which would have required about fourteen plates or 39 pounds of steel plates; the inspector, however, required me to put plates under all berth-deck hatch coamings, an item amounting in the aggregate to about 1,000 pounds of steel plates not called for in specifications or plan.

With reference to calking of decks, both main and berth decks were originally calked with two threads. The main-deck and berth-deck under bulkhead cleats were subsequently recalked, the former with two threads and the latter under bulkheads with one thread. It was then thought best by the inspector and Advisory Board to defer the recalking of balance of berth-decks until the ship should be completed.

In the memoranda of work required to complete the vessel, made by the Advisory Board and the inspector at the conclusion of the last steam trial, nothing was said about recalking, and I presume it may have been an oversight on their part. All the work in the bread-room, as far as sheathing with wood and tin is concerned, was completed in compliance with the wishes of inspector, but the grating was an oversight of my own, as I was furnished with the specifications; this grating, however, I have since furnished. The members of the Advisory Board and the inspector decided that it would be necessary to paint the awning stanchions, and preferred not to have them galvanized.

Additional beams on berth-deck for stiffening deck to resist calking were asked for by the inspector and furnished. The deck fastenings alleged to have been placed in the seams were put in diagonally, the deck being reamed and calked without any in-

terference from the deck screws. Aside from this the additional fastenings exacted by the inspector would compensate for any insufficiency.

Yours, respectfully,

JOHN ROACH.

Capt. GEORGE E. BELKNAP, U. S. N.,
Senior Member of Board.

Supplementary Report of Examining Board.

NEW YORK, *June* 23, 1885.

SIR: In obedience to the Department's order of the 20th instant, the undersigned members of the Examining Board visited the Dolphin on the 22d instant, in the dry-dock, Erie Basin, Brooklyn, N. Y., and found two garboard keel plates off on the starboard side and one plate off on the port side, under the engine-room.

These plates, which had been in contact with the rocks on the occasion of the vessel's grounding on the reef in the East River, seemed to be sound and free from cracks, thus indicating good material; but it was seen that some of the rivet holes of the keel, laps, and frames were unfair, and that clearly-defined lines and patches of rust on the center or keel plate and the floor plate showed that the space had not been properly cemented in all places.

Men were at work forcing the keel plates back into shape, under the inspection of Mr. Samuel Archbold, of the Naval Advisory Board, and Assistant Constructor Jno. F. Hanscom.

Mr. Sinclair Stewart, representing the Board of Underwriters, and Mr. Roach were also present.

The tail nut of the propeller shaft having been unscrewed, it was seen that the propeller hub had not been loosened from the shaft or in any way injured.

In parts of the vessel's bottom the plating showed wavy and unfair workmanship, especially along the seams.

Commander R. D. Evans, of the Board, did not receive his orders in time to be present at this inspection, having been at work in the Chesapeake in the performance of his duties as light-house inspector.

Very respectfully,

GEO. E. BELKNAP,
Commodore, President of Board.
HERMAN WINTER,
Constructing Engineer, Member.

HON. W. C. WHITNEY,
Secretary of the Navy, Washington, D. C.

The Secretary of the Navy to the Attorney-General.

NAVY DEPARTMENT,
Washington, June 17, 1885.

SIR: Herewith I transmit a copy of the report of the board appointed by me on the 7th of April last to examine and report upon the dispatch boat Dolphin.

I desire you to examine this report and to advise me what upon the law applicable to the case is my duty in the premises. The facts and

circumstances connected with this examination and the matters with reference to which I desire advice are briefly stated as follows:

Immediately after my accession to this office papers were presented to me for my signature accepting the Dolphin in behalf of the Governm Upon a cursory examination of the papers, made for the purpose of de-termining to what extent I had responsibility in the matter, my tion was attracted to the singular looseness of the contract. was a notable absence of effective stipulations, as it seemed to There was, however, one positive requirement contained in the section of the contract, intended to insure a certain minimum power, which provided that upon her trial trip "the collective indi horse-power developed by said engines under the prescribed tions shall be two thousand three hundred, and maintained suc fully for six consecutive hours; provided that, in case of the failure of the development of this power, the vessel shall be accepted if it can be shown to the satisfaction of the Naval Advisory Board and the Secretary of the Navy that this failure was due neither to defective workmanship nor materials." This trial having been had in Long Sound, under conditions favorable in the main, she had yet failed of meeting this requirement, having developed but two thousand o dred and eighteen horse-power for the six hours. The Naval Ad Board in referring to this had stated that they were of the opini this deficiency "was not due to defective workmanship nor ma but that with better coal and a well-trained engineer's force th results will be exceeded." For the purpose of verifying this pr and to satisfy myself, as appeared to be my duty, I wrote upon t of March, suggesting to the contractor another trial. As the p of the trial had been fixed in Long Island Sound by the persons auth under the contract to prescribe the conditions of the trial, and as terms were not more severe than those exacted by other nations, I expected an immediate favorable reply to this reasonable request. It was acceded to on the 5th of May, over six weeks having elapsed.

In the mean while an examination of the dealings of the Department with the contractor, and especially the manner in which the reserved payments had been surrendered to the contractor, induced me to select three competent persons to make thorough examination for the purpose of my advisement as to (1) whether the contract had been properly performed; (2) as to defects in the vessel; (3) as to the responsibility for the defects observed, if any. The result of that examination, made with great patience and intelligence, is herewith submitted for your consideration.

I now desire an examination of the contract and the law by you, that I may be advised whether, representing the Government, I have on my hands what is in the nature of a bad bargain or a broken contract. The report demonstrates that the Government has not got in the Dolphin what Congress stipulated for and what should have been obtained.

There are three general subjects considered by the board: First, the speed; second, the strength; third, the general workmanship.

First, as to speed. The act of Congress under which the Dolphin was built provided for an appropriation "for one dispatch boat, as recommended by the Naval Advisory Board in its report of December 20, 1882." By referring to that report it will be found that the recommendation was for the construction of "one dispatch vessel or clipper, to have a sea speed of fifteen knots." A reference to the report of the Advisory Board then before Congress, and the testimony which had been taken by its committees upon the subject of the new cruisers, shows that

for a sea speed of fifteen knots, a smooth-water speed over measured distance of seventeen and one-half or eighteen knots is required. Similar vessels able to show a speed of eighteen and even nineteen knots were referred to before the Congressional committee as being in course of construction by other nations. It may, therefore, be said to have been the just expectation of Congress in appropriating for the Dolphin, considering the state of the art, that she would be able to show at least seventeen and one-half knots speed upon her trial. Her highest speed for six hours was fifteen knots, as you will observe by examining the report of the board, and she has not at any time developed and maintained for six hours the two thousand three hundred horse-power required by the contract. Instead of being a dispatch boat of fifteen knots sea speed, the result of these various trials indicates something between twelve and thirteen knots as her probable sea speed in service. In view of the purpose for which she was built—a dispatch boat—and the state of the art with reference to speed of such vessels, it is apparent that this contract has not produced the result intended by Congress.

Second. As to her strength: From the report of the board it would seem that the evidence upon this subject is somewhat meager and rests considerably upon opinion in the absence of a sufficient sea trial. The English rules in similar cases, as I am informed, generally provide for a run of two or three days at sea. The opinion is expressed by the board that she has not the requisite stiffness. This opinion is based upon the vibration of the ship when under way, and the yielding observed in her floors and the effect of an unequal load, as seen when a small quantity of pig iron was loaded on her forward, causing her machinery to get out of line and her journals to heat. Her last two trials, according to the report, were accomplished only with streams of water pouring upon her journals during the trips. These facts seem to the board to indicate great structural weakness, to what extent, only a sufficient sea trial will demonstrate.

Third. As to the general character of her workmanship: The contract provides specifically (3d section), "the materials and workmanship used and applied in the construction of the hull and machinery and fittings of said vessel, in details and finish shall be first-class and of the very best quality." The character of the material is substantially beyond inspection now. The general workmanship and finish is criticised by the board, but as the contractor has been steadily at work at this, and expresses willingness to make the details satisfactory, so far as he is able, I think the Department could doubtless deal with that matter without legal advice.

The whole matter comes in the end to this: The Government is not receiving what it expected and had a right to expect from the construction of this vessel. The question which I desire answered is, whether the Department has in the matter a bad bargain simply, which as between contracting parties it must stand to, or has it a broken contract entitling it to insist upon something better. In connection with this question I desire to be advised what is the effect of the circumstance that the construction has been supervised by Government officials, material passed as sufficient, and the workmanship similarly approved, from time to time during the construction. The contract provides for this supervision and inspection, and I am advised that it has taken place as the work has progressed. Upon this subject I call your attention to the fourteenth section of the contract, which provides "that it shall not, under any circumstances, be obligatory upon the party of the sec-

ond part to accept the vessel or any part thereof to be constructed under this contract unless the same shall have been completed in strict conformity with this contract, under the supervision of the Naval Advisory Board, and in accordance with the provisions of the act of August 5, 1882," &c.

If the supervision and inspection that has been had is a bar, so that the Department cannot go back and examine work passed and approved by its inspectors and by the Naval Advisory Board, that ends the consideration of the matter. If it is not a bar, how far is the contractor responsible for the speed, strength, and general workmanship of the vessel, and what are the remedies of the Department under the circumstances?

I the more willingly avail of the privilege of referring this matter to your judicial judgment and advice, lest that in a spirit of resentment at this result I should be unjust.

I have the honor to be, very respectfully yours,

W. C. WHITNEY,
Secretary of the Navy.

Hon. A. H. GARLAND,
Attorney-General.

The Attorney-General to the Secretary of the Navy.

DEPARTMENT OF JUSTICE,
Washington, June 30, 1885.

SIR: Your communication of the 17th June instant requests my opinion as to the rights and duties of the United States touching the dispatch boat Dolphin, recently constructed by Mr. John Roach under a written contract entered into between him and your predecessor, the honorable William E. Chandler.

This vessel, you inform me, has been found to be defective in three particulars, two of which are fundamental; that is to say, (1) she does not develop the power and speed which the contract calls for; (2) she is not staunch and stiff enough for the service expected of her; and (3) the general character of her workmanship does not come up to the requirements of the contract.

As to the defect in the article of speed. The act of Congress under which the vessel was built (22 Stat., 477) makes an appropriation for the construction of "one dispatch boat, as recommended by the Naval Advisory Board in its report of December twentieth, eighteen hundred and eighty-two." Upon reference to that report it will be found, as I am informed by you, that the Board recommended the construction of "one dispatch vessel or clipper, to have a sea speed of fifteen knots," and I take it as very clear that the recommendation became, by force of this reference to it, as much a part of the statute as though it had been recited therein word for word.

The contract contains no express covenant as to the speed of the vessel—unless one is necessarily involved in the stipulation for a "collective indicated horse-power" of two thousand three hundred—but its very first covenant is to construct a dispatch boat "in conformity with the aforesaid plans and specifications hereto annexed, and in *accordance with the provisions of the acts of Congress approved August* 5 *and March* 3, 1883, respectively, before mentioned and relating thereto,"

and I am of opinion that the covenant bound the contractor as effectively to make a ship "of the sea speed of fifteen knots" as though he had agreed to do so in express words.

It may be said, possibly, that the covenant as to power and speed is not absolute, but qualified by the provision that, if upon the trial trip the engines should not develop the full power called for by the contract, and the failure should not be due to "defective workmanship or materials," the ship should be accepted by the Government nevertheless.

This attempt to bind the Government to take from the contractor's hands a ship of less power and speed than what the act of Congress peremptorily requires, is, in my opinion, utterly null and without effect. It was to the quality of speed more than any other that Congress was looking, as the terms "dispatch vessel or clipper," used in the report of the Advisory Board referred to in the law plainly show. Congress deemed that the service required a swift vessel of a sea speed of fifteen knots, and it directed such a vessel to be contracted for and built.

The contractor cannot be heard to allege ignorance of the very law under which the contract was made. He was bound to know the source and extent of the authority of the official with whom he contracted. "Individuals as well as courts," say the Supreme Court, "must take notice of the extent of authority conferred by law upon a person acting in an official capacity, and the rule applies in such a case that ignorance of the law furnishes no excuse for any mistake or wrongful act." (Whiteside *et al.* *v.* The United States, 93 U. S., 257; Hawkins *v.* United States, 96 U. S., 691; The Floyd Acceptances, 7 Wall., 666.)

With a full knowledge of the statute authorizing the construction of a dispatch boat of a designated speed and no other, and with the plans and specifications under which the work was to be done laid before him that he might bid with intelligence and safety, the contractor, if he had misgivings whether a vessel planned like the Dolphin would make the required speed, should have abstained from sending in proposals, knowing as he did, or ought to have done, that a ship defective in point of speed could not be accepted under the statute, whatever her merits might be in other respects.

Under any other view the most imperative requirements of Congress would be liable, at all times, to be evaded upon one pretext or another. I cannot conceive how it could be seriously urged that the United States is bound under the law in question to accept from the contractor any other sort of vessel than the one ordered by Congress to be built—namely, a dispatch boat or clipper of a sea speed of 15 knots; and the Dolphin having been found not to be a vessel of that description, as I must assume, it would seem to follow that nothing short of an act of Congress could authorize her acceptance.

I come now to consider the next objection, that the vessel is wanting in the necessary strength and stiffness. If this defect exists, as I must assume, it is fatal, whether due to the plans upon which the vessel was built or not, because, by the ninth clause of the contract, the contractor and his sureties stipulate "that the vessel constructed under this contract *shall be sufficiently strong to carry the armament, equipment, coal, stores, and machinery* prescribed by the Naval Advisory Board and indicated in the annexed drawings and specifications * * * ."

Now, it is too plain for serious discussion that the contractor has by this covenant undertaken to make a ship for a specific purpose in accordance with given drawings and specifications, and has, to all intents and purposes, warranted that the ship so agreed to be built shall be "sufficiently strong" for that purpose. In a word, the contractor, by

that the ship was so constructed, when in truth it was not, validity whatever to a pretended act of acceptance. It was tention of Congress that the United States should be foreclo cluded in any such way, or that any departure from the contr as expressly provided for, should be condoned by the act or of any official, and that it should be open, at all times, to sh vessel alleged to have been built and accepted under the la so built and accepted. It was competent for Congress to cre traordinary barrier of this kind against fraud and inefficienc the duty of those called upon to apply their language to do a way as to make it effective.

The case of the Floyd Acceptances, already referred to s difficult it is to bind the Government, by the [illegible] of its [illegible] matter of contracting for and disbursing its mo [illegible]

viduals or private parties, I do not think that the party occupying place of the Government would be estopped by the action of the ıvisory Board, or any intermediate agent, by whatever name such nt might be known. In Glacius v Black. 50 N. Y., 145, the court peals of New York considered this question very elaborately, after exhaustive argument, analyzing and applying many cases that cited in argument, and by a unanimous opinion, Church, chief , speaking for the court, ruled as follows:

ere, by the terms of a contract for the repair of a building, it is stipulated that material shall be of the best quality, and the work performed in the best manner, ject to the acceptance or rejection of an architect, all to be done in strict accord-ce with the plans and specifications, and to be paid for when done completely and cepted, the acceptance by the architect of a different class of work, or of inferior terials, will not bind the owner, and does not relieve the contractor from the eement to perform according to the plans and specifications; the provision for ptance is an additional safeguard against defects not discernible by an unskillful son.

This case, it is conceived, goes the full length to relieve the Govern-nt, in this instance, as against anything in the nature of an estoppel; in this opinion (50 N. Y.) the court says: "*Fraud or mistake vi-s the certificate in those cases where a certificate is otherwise conclusive.*" that, as upon a final inspection and trial of this vessel, it has been that a certificate has been given, or an acceptance made, of work did not comply with the requirements—and whether this was ugh fraud or mistake it matters not—that action is not conclusive, the Government is not bound thereby, as an individual would not in a similar case.

In Bird v. Smith, 64 E. C. L. R., 785, the contract was for the sale d delivery to the plaintiff of a quantity of iron rails, of certain weights, shapes, and dimensions, and to be inspected and certified as then agreed upon, and in quality equal to any rails made in Staffordshire. A plea that the rails were inspected, certified, and approved by an agent of he plaintiff, as provided in the contract, was held bad on demurrer, on ground (among others) that each stipulation is in its terms distinct, l in its nature, as an absolute warranty for quality, may well be re-quired, in addition to a provision for inspection and approval, to guard against defects which inspection cannot discover.

It is not deemed necessary to say more upon this feature of the case.

All that has been said thus far is based upon the idea that there is a valid, subsisting contract; but it is proper at this point to say that the visions of the contract binding the United States to accept the el on the approval of the Naval Advisory Board are in my opinion oid and inoperative, as shifting a high trust and duty from the Secre-ary of the Navy to the Board, in violation of the act under which the tract was made, which directs the Secretary of the Navy to invite posals, which authorizes the Secretary of the Navy "to construct l vessels and procure their armament," which requires proposals for work to be "subject to all such rules, regulations, superintendence, nd provisions as to bonds and security for the due completion of the work as the Secretary of the Navy shall prescribe," and which author- the Secretary of the Navy to use for the purposes of the act the ance of an appropriation made for another object. In the face of se explicit provisions it seems to me impossible to reach any other clusion than that Congress, after providing the Secretary of the y with abundant facilities for forming an intelligent judgment, nded that the full and ultimate responsibility of carrying out the should be on him.

This, however, while proper to be mentioned, is perhaps not of practical consequence, in view of the contractor's express covenant, already referred to, to do the work in accordance with the law authorizing it.

But beyond these questions there lies another of very great im tance, not referred to in your communication or the report accompanying it, and that is whether there was *any valid contract at all* between Mr. Roach and the United States.

As we have seen, the Secretary of the Navy had no power to cont for a dispatch boat that would not make fifteen knots at sea, or to accept any boat not built "in strict conformity with the contract" he authorized to enter into.

But the ninth clause of the contract provides that should the engines of the vessel contracted for fail to maintain successfully, on the trial trip for six consecutive hours, a power of two thousand three hundred horses, the vessel shall be accepted nevertheless, if it appear satisfactorily that the shortcoming was not owing either to defective workmanship or materials. In other words, it was to make no difference how much the engines should be wanting in power, and consequently how far short they should fall of propelling the ship at the speed requi by the law, it being impossible to dissociate power from speed, if there was no defect in the workmanship or materials. The obvious intenti of this was to relieve the contractor of all duty and responsibility as to the speed and power of the ship, and make it feasible to force upon United States a ship wanting in the prime quality of speed and fundamentally different from what Congress authorized and was so desir to secure. It needs no further discussion to show that what was thus attempted was wholly out of the question.

But the contract is an entirety, and does not admit of being broken up into fragments, so as that what is good may be enforced and what is bad rejected. The stipulation which was intended to relieve the contractor of responsibility for the power of the engines, and, as a necessary consequence, for the speed of the ship, forms a large and most important part of the consideration moving to him from the Government. It is impossible to say what was its bearing on the whole contract, nor is it material to do so, inasmuch as it and the other covenants of the Government constitute one entire and indivisible consideration, the invalidity or illegality of any element of which must necessarily vitiate the whole and abrogate the contract.

This is very well illustrated by the case of Chater *v.* Becket (7 T. 201), which is often referred to in illustration of the principle I rely. In that case a parol, and therefore invalid, promise to for the debt of another and a promise, entirely valid and meri formed the consideration of the contract sued on; and in view of defendant's contention that the consideration was void *toto*, it insisted, on the part of the plaintiff, that the defendant answerable for so much of his contract as was valid, but the court in reply, that the agreement was entire, and be no recovery on one part, the other part being illegal. by Chief-Justice Gibson, "If any part of an *indivisible pr*, or part of an *indivisible consideration* for a promise, is ill void." (Filson *v.* Himes, 5 Pa. St., 456.) In the lat eration was, like that in the case before me, made up o ulars, one of which was illegal; and the learned j illegal part, says, "Who can say from this how into the defendant's computation of what he

refer also to the cases of De Beerski *v.* Paige (36 N. Y.. 537); ı *v.* Pettit (32 Ala., 289); and Doty *v.* Knox County Bank (16 Ohio 134), as directly in point.

It follows, then, that no contract exists between Mr. Roach and the i l States, and that the large sums of money which have been paid Roach have passed into his hands without authority of law, and are by him as so much money had and received to the use of the United a and may be recovered from him. And not only so, but the money is paid him by officials holding a fiduciary relation to the Government ving gone into the ship Dolphin, a court of equity will follow it there, for that purpose entertain a proceeding against the ship itself. In ort of this position I need do no more than cite the recent decision the Supreme Court of the United States in the case of the National k *v.* Insurance Company (104 U. S., 55).

I have the honor to be, sir, your obedient servant,

A. H. GARLAND,
Attorney-General.

The SECRETARY OF THE NAVY.

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tement of Naval Advisory Board concerning the criticisms on the U. S. S. Dolphin.

The criticisms of the examiners are taken up as nearly as possible the order which they occur in their report and its appendix; the marks on each subject have been collected, quoted, and are immedi- y followed by our remarks.

STRUCTURAL STRENGTH.

To locate accurately the causes of the weakness observed in her would necessitate expenditure of a very large sum of money in taking out the machinery, &c.

That the Dolphin has not the requisite strength and stiffness to enable her to ke the speed required under the conditions she must be prepared to meet, admits no doubt in the opinion of the Board.

On the occasions referred to (trials in Sound) the vibrations of the Dolphin, when subjected to only that duty and test, were very perceptible and of a character to demtrate inadequate stiffness.

Under such circumstances, the floor of the engine-room was observed to spring severely. And this, let it be noted, occurred when she was subjected to much less severe duty than when actually engaged in the service for which she was intended.

se facts, so obvious to the Board, needed no corroboration, but corroboration was lished on the second of the unsuccessful trial trips witnessed by the Board. On that occasion her after crank-pin became hot after a short run—even before the actual trial had been begun. This pin had given no trouble on the previous trial, and the Board was informed by the contractor and his men that it had never before given any trouble. only reason apparent for the cause of the trouble on this occasion and the one which it was doubtless due, is to be found in the following facts: On the previous cessful trial about 40 tons of pig iron had been put in the forward part of the ship to trim her. Five tons more were added on this occasion, and, of course, some portion of the coal had been consumed from her bunkers. Even these slight changes he situation of her weights were seemingly sufficient to alter her shape so as to this after crank-pin to heat almost at once.

erefore the question arises, Is this structural weakness due to a fault of plan execution, or does it proceed from both?

In justice to the contractor, it is proper to state that the plans exhibited to the ard and those furnished to the contractor are very meager, and by no means proue for a vessel of adequate strength for the uses for which the Dolphin was inded.

While it is clear that the plans are at fault, and, if carried out in the best manner, uld not produce a vessel of sufficient strength, yet it seems to the Board that the

Dolphin exhibits a degree of weakness in excess of what can properly be entirely attributed to defective plans. Wherefore the Board is of the opinion that the execution must be faulty in this regard; but it is impossible to state with exactness the degree of blame that might properly attach to the contractor in this precise respect without taking out the machinery and opening up the ship—a work, as previously stated, involving a large expenditure of money.

The Board * * * has to regret that so much of the vessel's strength rests upon opinion. Nothing short of a trial at sea for some time and in rough water can satisfactorily determine her actual strength or weakness.

Ad. p. 7. (Referring to the trial of May 12.)

The vibrations of the ship during the run were of such a nature as to indicate a lack of structural stiffness which, in the opinion of the Board, will be likely to rack and weaken the ship, especially under full power in a sea-way. The floors forming the engine-room foundations spring severely, even when running under ordinary power in smooth water, and in the opinion of the Board, additional stiffness should be provided under the engines and intermediate between them and the after bulkhead of the engine-room, in the way of webbed frames forming cross-floors extending up to the lower-deck stringers, and from this by suitable proportions to shape for passage-way to extend to main-deck stringers.

The working of the steam-steering engine caused a severe vibration of the after part of the vessel, due, in the opinion of the Board, to the unusual character of the steering apparatus applied for a naval vessel.

Ad. p. 8 and 9. * * * but the 40 tons of pig-iron ballast, placed in the forward end of the ship on the trial of the 12th instant, and the 5 tons more of like ballast, put on board in the same part of the vessel, on the occasion of this second attempt, together with the lessened weight amidships in the amount of coal consumed from the bunkers in the running of the engines for many hours alongside dock, as well as in the river and Sound before the trial could be carried out, have had something to do with the failure of the machinery to work properly. ... such be the fact, it indicates nothing less than structural weakness of the vessel, ... firmatory of the impressions of the Board, as expressed in another part of this rep...

The above statements clearly bring against the Dolphin the most ... rious charge of structural weakness, due to faulty design and agg... vated by defective workmanship.

The alleged evidence in support of this charge consists of (1) vibrations of the structure while under full speed; (2) heating of two crank-pins on two successive occasions. This evidence is presented and distinctly attributed to lack of structural strength; yet, in closing t... report they state that they regret that the matter rests upon opinion, an... that nothing short of a trial at sea for some time in rough water can satisfactorily determine her strength or weakness.

We now propose to show that the Dolphin is a strong, staunch v... sel, and the above opinion was formed in the utter absence of positive evidence, and could not be derived from an examination of the facts.

As the absolute size of the vessel enters into a question of this ki... it is allowable to recall the dimensions of the Dolphin—240 feet len... between perpendiculars, 32 feet beam, 19.8 feet depth, and 1,500 t... displacement.

In examining the strength of a complex structure, the first inquir... naturally as to the strength of the material and the fastenings. ... structure of the Dolphin is composed of the best quality of mild stee... and a most careful and elaborate series of tests on the whole of frames, angles, and plates show an average ultimate tensile strength ... 28.5 tons per square inch, and an average ductility in 8 inches of 25 ... cent. The rivets, upon which the strength of the whole structure depends, are also of steel, and are probably the most reliable, unifo... and tough material ever used for the purpose. The shearing strength of a $\frac{3}{4}''$ steel rivet in a $\frac{13}{16}''$ hole is found to be 12 tons, which exce... by more than 20 per cent. the strength of the finest iron rive...

Next in order we examine the arrangement and distrib... of material, and will, therefore, briefly describe the structure of ... p...

Dolphin is framed on the transverse system, commonly adopted chant vessels.

side-bar keel is composed of a center plate, 33″ deep and weigh- pounds per square foot, or ½″ thick; of two side bars 9″ by 22½ s; of the rider plates at the top, each 12″ wide by 15 pounds, and ntinuous angles securing them to the middle plate and the reverse s, each 5″×3″×10 pounds. The frames are spaced 22″, from cen- center, and are composed of 4″×3″×9 pounds frame, and 3×2½×6 s reverse angles, with floors 18″ deep and 12½ pounds per square the reverse frames being carried up to the main deck on every , except right fore and aft, where they are carried to the berth on alternate frames. The plating is worked in 14′ 8″ lengths, the ards are 25 pounds per square foot, and the remainder of the bot- lating 17½ pounds. The sheer strake is formed by a doubling 4 feet wide. The plating is double riveted at the edges and butts, t in the flush plating above the water, which is secured at the by single riveted edge strips, except at the sheer strake, where re double riveted.

spar deck beams are 7″ T-bulb, 25 pounds per foot length, one on alternate frame, or every 3′ 8″. The deck is plated throughout ngth of the engine and boiler spaces, or 90 feet amidships, with 15- plating and single-riveted edge strips and treble riveted butt . Before and abaft the engine spaces the plating tapers to 10 s per square foot at the extremities and the stringer plates, which pounds amidships, to 12½ pounds. The outer angle securing the er to the side of the deck is 3″×3½″×8 pounds, and the water way ned by two angles 3″×3″×8 pounds, and 2½″×2½″×5 pounds. eck is laid with 3½″ pine planking secured with wood screws.

berth deck beams are of the T bulb pattern 6″ deep by 16 pounds neal foot. The stringer on this deck is 32″ wide and 12½ pounds uare foot, secured to the deck plating by short angles 3″×2″×6 s, and by a continuous angle of the same dimensions to the reverse s. This stringer tapers to 10 pounds forward and aft, and in all where it is cut for coal chutes or anything of the kind it is amply ensated by doubling plates. Forward and abaft the engine and spaces a central tie plate 36″ wide extends from aft to the col- bulkhead and forward to the stem.

addition to the longitudinal strength provided by the decks, keel, plating, there are three keelsons between the berth deck and the or this purpose and to stiffen the bottom. The upper bilge keel- onsists of two angles 5×3×10 pounds per foot placed back to back ecured to each frame by a double reverse clip, long enough to take rivets on the frame. This extends continuously from the stem e it forms the breast hook next below the berth deck to the after ion, or stuffing-box bulkhead, where it ends just below the berth

e lower bilge keelson consists of intercostal plates, 12½ pounds per e foot, secured to the outer plating and floors by short angles 3″× 5 pounds per foot length, and to the reverse frames by two con- s angles 5″×3″×10 pounds. The angles of this keelson are con- s between the transverse bulkheads in the fore and after hold, 45 feet from the stem and stern, where they join the orlop deck The intercostal plates end forward at the forward fire room bulk- and aft at the after engine room bulkhead.

side keelsons are made up similarly to the lower bilge keelson

except the plate is continuous at the top and jogged over the frames. The angles extend 10 feet forward and abaft the bulkheads in the fore and after hold and the plates extend to these bulkheads. These keelsons are not continuous through the engine room as they come too near the engine keelsons; therefore they continue one frame space into the engine room at each end, and are then replaced by a pair of 5″ × 3″ × 10 pounds angles midway between the engine keelsons and the lower bilge keelsons.

The main transverse bulkheads in the ship are composed of plates weighing 12½ pounds, tapering to 10 and 7½ pounds at the top, except the collision bulkheads which are 15 pounds to 10; the plates are lapped and single riveted at the edges and butts, and stiffened by vertical 3″ × 2½″ × 6 pound angles 30″ apart. They are secured to the plating of the skin by 3″ × 3″ × 8 pound angles. All the main bulkheads extend water-tight to the main deck, and are situated as follows: (1) Forward collision, 11 feet abaft the stem; (2) in fore hold between chain lockers and fore hold 47 feet abaft the stem; (3) 36′ 6″ abaft this is the bulkhead forming the forward end of the boiler compartment. This compartment is 48 feet long and separated from the engine compartment by a coal bunker, 11 feet long, formed by (4 and 5) two complete bulkheads. The other coal bunkers are at the sides and above the boilers, and in a bunker just forward of the boiler compartment on the berth deck.

The engine room is 29.5 feet in length along the keel and (6) the bulkhead at the after end extends to the berth deck, which is there plated water-tight from thence four frame spaces forward, from whence the bulkhead is carried to the main deck. (7) At 22 feet abaft the lower engine room bulkhead, or 45 feet from the stern post, comes that in the after hold which separates the cabin and ward room. The (8) after collision bulkhead is 17.5 feet from the stern post, but at the level of the berth-deck jogs six frame spaces aft to save room.

These are the principal structural arrangements of the vessel. The local strength has been carefully attended to in the hatch coamings of the engine and boiler hatches, the pillaring throughout, and especially around hatches and in the boiler spaces; the beams under the track of the pivot gun are 8″ deep and closely pillared; an 8″ I-beam forms a transverse tie in the center of the boiler space at the level of the berth deck. The boilers are set fore and aft on athwartship bearers of the usual form and of great strength, the reverse frames being doubled throughout the boiler compartments. The framing under the engines is formed by increasing the depths of the floors to 36″ and their weight to 17½ lbs, increasing the depth of the thrust block, center and side keelsons in the same proportion, and covering the whole with a ¾″ steel plate extending about 1 foot beyond the edge of the engine bed plate. The reverse frames being fitted at the usual height of the floors and doubled throughout the engine space.

We have compared the scantlings of the Dolphin with those prescribed by Lloyd's rules for a vessel of her dimensions, of the highest class 100 A, with the following result:

SCANTLINGS OF THE DOLPHIN.

Dimensions of ship for Lloyd's rules, 245′ length, 31′.86 molded breadth, 19′.8 molded depth. Half girth, 30′. Length = 12.37 × depth = 7.7 × breadth.

No. for frames, 65.73. Plating No. 16,103.

Parts.	Lloyd's iron.	Lloyd's steel.	Lloyd's steel, in pounds.	Specifications of Dolphin.
Frames	4″ × 3″ × $\frac{7}{16}$″	4″ × 3″ × $\frac{6}{16}$″	4″ × 3″ × 8.45 lbs	4″ × 3″ × 9 lbs.
Reverse frames	3″ × 3″ × $\frac{6}{16}$″	3″ × 3″ × $\frac{5}{16}$″	3″ × 3″ × 6 lbs	3″ × 2½″ × 6 lbs.
Bulkheads	⅜″	$\frac{5}{16}$″ to $\frac{4}{16}$″	10″ to 12½″	{Collision 15 lbs {10″ to 12½ lbs.
Keel	8½″ × 2½″	8½″ × 2½″	8½″ × 2½″	9″ × 2⅞″.
Stern	8″ × 2½″	8″ × 2½″	8½″ × 2½″	7″ × 2½″.
Stern frame	8″ × 5″	8″ × 5″	8″ × 5″	8½″ × 4½″.
Garboards	$\frac{11}{16}$″	$\frac{9}{16}$″	22½ lbs Bilge strakes, 20 lbs.	25 lbs.
Bottom plating	$\frac{9}{16}$″ × $\frac{10}{16}$″	$\frac{7}{16}$″ to $\frac{8}{16}$″	17.5	17.5 lbs.
r strake	$\frac{14}{16}$″	$\frac{11}{16}$″	275 lbs	2 of 17.5 lbs.
rs	19½″ × $\frac{8}{16}$″	19½″ × $\frac{6}{16}$″	19½″ × 15 lbs	18″ × 12½ lbs.
Floors under engines and boilers	19½″ × $\frac{9}{16}$″		20 lbs	17½ lbs.
Upper deck planking	3½″	3½″	3½ lbs	3½″.
Angles in lower stringers	4″ × 4″ × ½″	4″ × 4″ × $\frac{6}{16}$″	4″ × 4″ × 10 lbs.	5″ × 3″ × 10 lbs.
Angles in upper stringers	4″ × 4″ × ½″	4″ × 4″ × $\frac{6}{16}$″	4″ × 4″ × 10 lbs.	5″ × 3″ × 10 lbs.
Stringer on upper deck.	52″ × $\frac{11}{16}$″	52″ × $\frac{9}{16}$″	52″ × 22½	15 to 12½ lbs.
Iron deck	For ½ length of ship ⅜″.	½ length $\frac{5}{16}$″	½ l'gth 12½ lbs.	Full length, 15 to 10 lbs.
ng for shaft alley	$\frac{4}{16}$″ × − $\frac{6}{16}$″	$\frac{4}{16}$″ to $\frac{5}{16}$″	10 to 12½ lbs	10 lbs.
le line keelson plate	$\frac{10}{16}$″	$\frac{9}{16}$″	20 lbs	20 lbs.
plate at top of keelson plate	$\frac{9}{16}$″	$\frac{7}{16}$″	17.5 lbs	15 lbs.
es at top of keelson plate	5″ × 3½″ × $\frac{9}{16}$″	5″ × 3½″ × $\frac{7}{16}$″	5″ × 3½″ × 12 lbs	5″ × 3″ × 10 lbs.
keelsons	5″ × 3½″ × $\frac{9}{16}$″	5″ × 3½″ × $\frac{7}{16}$″	5″ × 3½″ × 12 lbs	5″ × 3″ × 10 lbs.
hip beams { 8″ × $\frac{5}{16}$ − 17.42 lbs. / 2–3″ × 3″ × $\frac{6}{16}$ − 7.07	Equivalent solid 8″ × 24.59 lbs.	8″ × 20 lbs	8″ × 20 lbs	7″ × 5″ × 25 lbs.
Frame spacing			23″	22″.

Showing that in all essential matters the requirements of Lloyd's are eeded. The rules require in the engine space two web frames which have not been fitted; they could not be got in on the starboard side owing to the location of the pumps, and it was not considered necessary lo more than make the double reverse frames on four beams the weight as the frame angles, on account of the unusually short h of the engine room, only 22 feet at the upper part. The rules re- e a heavier stringer plate on the upper deck than we have fitted, on the other hand they require the deck to be plated for the full breadth of the ship for only one-half the length, whereas the Dolphin has a complete steel deck throughout her length.

It is proper to notice here that in designing a naval vessel which carries to a comparative extent a definite fixed load of small variation, it is always found desirable in some respects to depart from the requirements of the registration societies, which by their tables prescribe the scantling for a vessel of certain proportions which may be of any form as regards the lines and for any class of service from carrying coal to pig iron. Therefore, it is often possible in designing a vessel for the naval service to save weight in the hull to be efficiently used for other purposes; in fact, it is only by the most careful attention to matters of this sort that any progress can be made in ship design.

Having now sufficiently indicated the nature and particulars of the structure of the vessel, we will now discuss briefly the question of whether it is sufficiently strong to withstand the stresses to which it may be subjected. We are well aware that there is nothing that is more certain to bring to light any latent defects which may exist in a vessel, either local or structural, than heavy weather at sea, and that under these conditions weakness may develop itself in ships which

appear to be strong and well built; but here we have to deal with a question of structural strength, concerning which there are well-recognized methods of investigation; these have been followed out with care, and we have also made investigations quite beyond the ordinary course.

In discussing the strength of a vessel the absolute size is of considerable importance, for the parts of a ship are proportioned not only with regard to strength of the structure as a whole, but with regard to durability and local strength. It is found that the structural strength of small vessels is very much greater than large ones on this account, for small and large ships corrode equally fast and other local influences are independent of the size; therefore, in the Dolphin, comparatively a small vessel, if the local strength has been carefully attended to, we should *prima facie* expect to find her amply strong structurally.

The chief strains to which ships are subjected are thus described by Mr. White, in his Manual of Naval Architecture:

(1) Strains tending to produce longitudinal bending, "hogging" or "sagging," in the structure considered as a whole.

(2) Strains tending to alter the transverse form of the ship; *i. e.*, to change the form of athwart sections.

(3) Strains incidental to propulsion by sails or steam.

(4) Strains affecting particular parts of a ship—"local strains"—tending to produce local damage or change of form, independently of changes in the structure considered as a whole.

Besides these there are other strains, of less practical importance, which are interesting from a scientific point of view, but need not now be discussed, as there is ample strength in the structure of all ships to resist them, and there is no necessity in arranging the various parts to make special provision against such strains.

The principal strains to which ships are subjected in still water are those due to the unequal distribution of weight and buoyancy, and though they are by no means so great as those experienced in a seaway, still they bear directly on the case in point, where it is charged that a weight of 45 tons in the bow so deflected the ship and sufficiently affected the alignment of the machinery as to heat the crank-pin journal. These investigations also give us the means of comparing the strength of the Dolphin with other vessels under conditions usually considered to measure the strength necessary to meet the strains produced in a sea-way.

When the Dolphin floats in still water loaded as if fully equipped for sea, with bunkers full and water in the boilers, the curve of loads obtained from a comparison of the weight and buoyancy throughout the length shows that for 41.2 feet from extreme aft, or to about the after pillow-block of the main shaft, there is an excess of weight over buoyancy of 40 tons; from thence to the edge of the engine bed-plate the buoyancy exceeds the weight by 107 tons distributed over 52.5 feet of length. Throughout the engine space to about 6 feet forward of the midship coal-bunker the weight is in excess by 63 tons. Throughout the space occupied by the boilers the weight and buoyancy are nearly equal, the buoyancy having an excess of 15 tons over a length of 29 feet. From there through the forward coal-bunker to the center of the magazines the weight is in excess by 44 tons. Then over a length of 41.5 feet there is a slight excess of buoyancy of 38 tons, and from thence to the stem an excess of weight of 13 tons.

It will thus be seen that there is no very marked load at any point, nor any combination of loads and supporting forces to produce a large bending moment; in fact, the maximum bending moment in still water, which tends to hog the ship, or to bend her upwards in the center, is determined to be but 2,200 foot-tons, or 1-167th of the length × displacement, or, in popular language, the moment that would be produced by

22 tons at the end of a lever 100 feet long. This occurs at 8 feet abaft the engine-room bulkhead, and produces a fiber stress in tension on the upper deck plating of 6-10ths of a ton per square inch, and a compression on the keel of 65-100ths tons per square inch. A fair working load for the metal would be 5 and 4 tons per square inch respectively, and thus the actual stress is hardly of any importance, which is what we expected to find.

The strains experienced in still water are much altered by the variations of the distribution of buoyancy when the vessel is rolling and pitching and traveling over waves. These various effects we cannot calculate, but we can take a case, which, though it does not presume to represent what the strains actually are, probably is a most unfavorable case as regards structural strength, namely, to suppose the ship to rest instantaneously on the crest and then on the trough of a wave of her own length.

When the Dolphin rests on the crest of a wave 240 feet long and 15 feet high, the maximum bending moment, which tends to hog the ship, amounts to 8,700 foot-tons, or 1-43d of the length × displacement. This occurs just abaft the smoke-pipe, and produces a fiber stress in tension on the upper deck of 2.4 tons per square inch, and in compression on the keel of 2.5 tons per square inch.

In the hollow of a wave of the same dimensions, the tendency is to sag the ship, the maximum occurring at the same place and being in amount about 11,484 foot-tons, producing a tensile stress of 3.7 tons on the keel and a compression stress of 2.9 tons per square inch on the upper deck plating.

Many calculations similar to these have been published in regard to armored vessels, which have unusual and concentrated loads, but comparatively few are available for unarmored vessels comparable with the Dolphin.

The following is a table taken from a paper in the Transactions of the Institution of Naval Architects for 1874, on "the strength of iron ships," by Mr. W. John, then surveyor to Lloyd's:

This table shows the stresses experienced by a series of vessels from 100 tons to 3,000 tons burthen, with scantlings of first-class iron vessels of the time, their proportions being nearly eight breadths in length and eleven depths in length.

Tonnage of vessel.	Maximum tension on upper works, in tons per square inch.
100	1.67
200	2.36
300	3.09
400	3.55
500	3.95
600	3.72
700	4.57
800	4.59
900	4.8
1,000	5.19
1,500	5.34
2,000	5.9
2,500	7.08
2,000	8.09

By this method of measurement the Dolphin would be about 800 tons burden.

These stresses are all calculated supposing the maximum bending moment to be 1-35th of the length multiplied by the displacement, and that this is a reasonable assumption for comparison with the Dolphin is shown by the following table, compiled from White's Manual of Naval Architecture and other sources:

Name of ship.	Description of ship.	Waves used in calculations.		Maximum bending moment = weight × length ÷ the numbers below.			Maximum tension on upper works in tons per sq. inch.
		Length.	Height.	Still water.	Wave crest.	Wave hollow.	
Iris	Twin screw steel high-speed dispatch vessel.	300	15	58	20	43	5
Dolphin	Single screw steel dispatch boat.	240	15	167	42.4	32	3.75
Victoria and Albert	Royal yacht, paddle, high speed.	300	20	139	43	23	....
Merchant steamer	Sea-going cargo-carrier	360	16	109	37	83	....

In a continuation of this subject—"strains of iron ships"—in the Transactions for 1877, Mr. John says:

"There are not wanting illustrations to show that where the maximum strain on a wave the length of a vessel comes out between 8 and 9 tons per square inch, want of sufficient longitudinal strength soon becomes apparent, and strengthening has to be resorted to. And below this, where the exceptional strains under the same conditions show from 7 to 8 tons, there is sometimes evidence of longitudinal weakness, but it is often complicated with other symptoms of straining; and in vessels of the same type and general scantlings, where the local strength has been better attended to, no signs of longitudinal weakness have been observable. Of vessels where the maximum strain by the same formula came out between 5 and 7 tons per square inch, there are hundreds afloat that have been working for years, through all sorts of weather, showing no signs whatever of weakness."

These limits of strength, it should be borne in mind, are given for English iron, and the Dolphin is built of American steel, which is from 50 to 60 per cent. stronger material. making our safe limits for these unusual and occasional stresses from 7.5 to 10 tons, whereas the greatest we actually found under these conditions is less than 4.

We now propose to show that the statement that an unusual load of 45 tons in the bow of the Dolphin was sufficient to alter her shape so as to heat the after crank-pin cannot be true. It seems almost unnecessary to go to so much trouble for this purpose, because even if the shape of the vessel had altered, evidence of it would not have been given by the heating of the after crank pin, as will be shown later.

We have demonstrated above that the Dolphin is structurally strong compared with the best modern practice. Now, in addition, we have constructed curves of weight and buoyancy in the exact condition of the vessel on the trial of May 12, when the after crank-pin heated. On this occasion the vessel was loaded with 45 tons of pig iron, the center of gravity of which was 11½ feet from the stem. This does not seem in figures a very great weight, but when we realize that it was equivalent to that of a modern 10-inch rifled gun with its carriage and all attachments, or two 15-inch smooth bore guns placed on the top-gallant forecastle, we can understand that it was a most extraordinary means of

bringing the vessel to her proper trim. The calculations show that in still water (the conditions of the trial) the maximum bending moment was 3,523 foot tons, 1-88th of length × displacement, which produced a tensile strength on the upper deck plating of slightly less than one ton per square inch; whereas we should not expect to see any signs of longitudinal weakness until the stress was 7 or 8 tons per square inch. The increase of bending moment due to the ballast of 45 tons was 1,000 foot-tons, and produced an increase of stress of 3-10 of a ton per square inch.

Now, we do not mean to say that the foregoing shows that the ship could not have altered her shape at any part, for there might be some local weakness, which question we will consider later; but we do mean to say that it could not have been due to lack of structural strength, and that if it had been, the crank-pin would have been about the last place to show it; for the engine shaft is elastic and bends readily with the structure, and all structures of elastic materials yield under loads to a greater or less degree, but the shaft is supported in some parts by long rigid bearings fixed to the hull, and both theory and experience sustain the statement that excessive deflections of the vessel are first shown in the line shaft bearings. They would naturally be shown in the main bearings before the crank-pins, because the crank shaft when subjected to bending moments, which it is constantly by the action of the steam on the piston, yields by the minute opening or closing of the crank-arms, which must be considerable before the pins would be affected. Further, the engine bearers and bed-plate form the most rigid part of the vessel, and therefore would be the last to yield.

We do not contend that the above investigations are conclusive to the extent that the Dolphin could not have shown signs of weakness; what they do show is that the Dolphin is structurally strong, so far as relates to the severest strains experienced by vessels under any circumstances, namely, those due to inevitable unequal distribution of weight and buoyancy. If the Dolphin showed any signs of weakness it must have been local. Places are pointed out by the examiners which are thought to be weak, as in the bow and stern compartments, but these are effectually disposed of separately. They say that "the vibrations of the vessel were such as to indicate a lack of structural stiffness." Here is apparently a distinction between stiffness and strength, and "that the floors under the engine room were observed to spring severely." If there is any local weakness it would probably be in the engine room, as the forces acting there are greater than elsewhere; however, special means were taken to provide for them, as elsewhere described, and we believe that in this case they have mistaken the inevitable vibration and yield of the structure for a local weakness, and our calculations and observations on the vessel bear out this opinion.

Taking the engine bearers as a longitudinal girder supported at the ends loaded by the dead weight of the engines less the supporting buoyancy over a reasonable area of the bottom, and by the accelerating forces or virtual changes of weight due to the motion of the reciprocating parts, we find the maximum sagging moment to be 257 foot-tons, producing a fiber stress on the upper parts of $2\frac{1}{2}$ tons per square inch. Now, actually, this girder is partly fixed at the ends owing to its connection to the hull, and it is probable that the actual stress does not exceed five-eighths of this, thus giving a factor of safety far beyond the usual limits. There is, of course, a fluctuation of the stress due to the motion of the reciprocating parts through a range of $1\frac{1}{2}$ tons per square inch,

or from eight-tenths tons tension to seven-tenths compression, which tends to loosen the fastenings.

Again, to illustrate the great strength of the transverse floors, we have calculated the deflection produced by a working load sufficient to produce a stress of four tons per square inch on a floor, with its accompanying plating, angles, and covering plate, considered as a girder supported at the bilges. Allowances have been made for the losses of strength due to the fastenings, but the stiffness of the keel has been entirely neglected, thus constituting a most unfavorable case; we find that the maximum deflection due to this load, which is about five times the actual load, is but .081 inch, or about one-twelfth of an inch. When the engines are moving at the rate of 76 revolutions per minute the engine frame can be observed to move up and down, up as the low-pressure piston starts down, and this motion is coincident with a vibration observable throughout the ship. The maximum amplitude of this motion is estimated to be between one-thirty-second and one-sixteenth of an inch.

If any excessive deflection of the floors had occurred it would have communicated itself to the bilges and the bulkheads, but no deflection or vibration could be felt or perceived at either one of these places.

With this statement of facts, we will discuss the vibrations, which have been carefully noted, and premise our remarks with a quotation from the last volume of the Transactions of the Institution of Naval Architects:

> All steamers, without exception, shake to a more or less degree when the engines are in motion. This phenomenon is usually considered as so natural that, in most cases, little or no attention is paid to it, and when ships with comparatively powerful engines show an unusually strong vibration, it is either looked upon as quite natural or the phenomenon is simply accounted for by saying the ship is of too weak construction. It will not have escaped the notice of those who have paid much attention to these vibrations that, not uncommonly, weakly-constructed ships with powerful engines exhibit only a small amount of shaking, and, conversely, that comparatively strongly-built ships are subjected to exceptionally violent vibration.

It is, in fact, quite easy to see on a simple analysis of the subject that the strength of a ship cannot be measured by the extent of the vibrations; for, when a force is applied to an elastic body it yields, and if the force is removed suddenly vibrations are set up which have a definite period. Now, if the force be also periodic the amplitude or violence of the vibrations will be greater or less according as the applications of the force and the period of the vibrations synchronize.

In the Dolphin, vibrations were observed in the hull, either on deck or below, of two apparently distinct systems, which are assigned to separate causes; the first was in a vertical plane, and corresponded to the motion observed in the engine framing. It appeared to be a maximum in amplitude just abaft the engines. As one goes forward, it perceptibly varies, decreasing until a few feet forward of the gun-pivot, where it is hardly apparent that there are any engines in the ship. From this point forward it increases again, becoming a maximum at the stem. The variation is similar going aft from the engines, but not the same, for there is no point where it entirely disappears, being a minimum not far from the mizzen mast and a maximum at the stern, where the amplitude appears to be slightly greater than at the bow. The same variation in the vibration is observable if one moves from the engine down the length of the shaft alley. This system of vibration is no doubt principally due to the alternating unbalanced forces produced by the acceleration of the reciprocating parts of the machinery, namely, the piston, piston-rods, and connecting rods. This will be understood

when it is known that as the low-pressure piston starts downward there is an upward force exerted on the bottom of 27 tons. These forces not only exert an alternate pull and thrust on the bottom, but the action of the two pistons of the high and low pressure cylinders form an alternating couple tending to rock the engine backward and forward.

The second system of vibrations are not so apparent except at the extremities of the vessel, and take place in a horizontal plane. They are due apparently to the intermittent action of the screw, due to the unequal pressure on the vertical blades, which is caused by the greater retardation of the water near the surface by the skin friction of the vessel.

In order to give a clear idea of the extent of these combined vibrations at the point where they were most marked, a glass of water was placed on the berth-deck a few feet forward of the screw; the glass was 3¼ inches in diameter across the top and was not held, but allowed to rest upon the deck. At the time the engines were making 76 turns by the watch, and the Sound was perfectly smooth so that the vessel had no perceptible rolling or pitching motion, the glass was gradually filled with water until the water touched the edge of a rule placed across a diameter. It would there remain so for any length of time without spilling a drop. This simple experiment, made on the trial of May 28, shows that the vibration so far from being excessive was very moderate. Even when the engines were suddenly put full speed astern and the rudder put hard over from side to side the vibrations were only sufficient to spill about $\frac{1}{32}$ of an inch out of the top of the glass.

Having now discussed the subject of strength thoroughly from an examination of the structure and from the circumstances of the trial we will conclude by stating that a searching examination of the hull of the vessel, while in dry-dock to repair some slight injuries incurred while aground on some rocks in the East River while under the contractor's charge, has not developed the slightest evidence of weakness in any parts or fastenings; the alignment of the engines remains perfect, and none of the signs by which experienced persons detect straining can be observed.

We now consider that we have shown, so far as it can be possible to show, that compared with other vessels the Dolphin is exceptionally strong structurally; that it is not reasonable to accept the fact of the heating of a crank-pin, to which engines, and particularly new ones, are at times liable, as evidence of weakness of any character; that vibrations are very moderate, unavoidable, easily explained, and cannot be regarded as evidence for or against the strength of the ship.

LOCAL STRENGTH.

Bow Compartment (Ad. p. 4). The bow of the ship does not seem strong enough to resist the shock and pressure of the sea when butting into it in heavy weather; and to prevent possible panting under such circumstances, double-angled stringers of the same size as the present upper and lower bilge keelsons should have been placed midway between the upper and lower decks from the inner part of the stem forging, aft to the second collision bulkhead, with connecting intercostals making attachment to the skin of the ship as far as may seem desirable, together with proper plate or angle breast-hooks within the collision compartment.

We are of the opinion that the strengthening of the bow of the Dolphin is ample not only to resist the pressure or impulsive force of the water in plunging into a head sea, but also to provide additional strength and such arrangements as would admit of ramming without excessive danger to the vessel. However, it may speak for itself; the stem is molded 7½

inches, sided $2\frac{1}{2}$ inches; the collision bulkhead, consisting of 15-pound or $\frac{3}{8}$-inch plating, is 10 feet abaft the stem at the load-line; between it and the stem are four frames consisting of $4'' \times 3'' \times 9$ pounds and $3 \times 2\frac{1}{2} \times 6$ pound angles, spaced 22 inches, apart. Stiffness is given by the following breast-hooks: at the spar-deck, by water-tight steel flat extending from the stem to the collision bulkhead made up of $12\frac{1}{2}$-pound or $\frac{5}{16}$-plate secured to the side by $2\frac{1}{2} \times 2\frac{1}{2} \times 5$-pound angles. Seven feet below this is precisely similar, flat at the level of the berth-deck which comes just to the water-line at the deep load draught. Two and a quarter feet below this is a breast-hook which is a continuation of the upper bilge stringer, and 3 feet below this is another breast-hook which is a continuation of the orlop-deck flat, and is connected to the stem by a short steel casting 2 inches thick; at this level the breadth of the vessel is 4 feet at the collision bulkhead and below this part the lower compartment is nearly filled with cement. All of this is covered by the outside plating, $17\frac{1}{2}$ pounds per square foot, or $\frac{7}{16}$ thick, double riveted at the edges and butts and rabbeted into the stem.

We have not the slightest fear that this plating will pant—that is, move in and out under the pressure of the sea. This action is always observed below the water-line, and usually only in heavy, deep-draught vessels. We regard the additional stringer suggested to be put in between the spar and berth decks, at a height of 4 feet above the load-line, as unnecessary and useless to remedy even an imaginary defect.

A short angle-iron stiffener was shown on the original drawings in about this location, but it became inconvenient to fit it on account of the hawse pipes, and it was, therefore, omitted as superfluous.

Fore Peak.—In describing the defects made good by the contractor, "she has been stiffened forward in the fore peak abreast the hawse pipes by a vertical plate brace, a point where special weakness was observed."

The only possible case in which the vertical plate brace, fitted by the contractor in deference to the opinion of the examiners, will be of any value would be to merely stiffen the side when veering to the chain. It is stated that "special weakness was observed," which must be merely a matter of opinion, as there is not the slightest evidence of weakness, although the Dolphin has been at anchor many times.

Hawse Pipes (Ad. p. 4). The water-tight covers on inner sides of hawse pipes are roughly made and of insufficient strength. In some of the recently-built merchant ships these hawse pipes are fitted with neat water-tight plugs, which answer their purpose admirably.

These covers are made of $\frac{1}{4}$-inch steel plate, tap-bolted to the inner flange of the hawse pipe, and they answer the purpose for which they were intended. The hawse pipes lead from a manger on the spar-deck under the top-gallant forecastle, and therefore it is not necessary that they should be always perfectly water-tight. If it had been, the rubber plugs referred to, used in the Miantonomoh, would have been employed.

After Transom (Ad. p. 2). In the after transom three beams are unsupported by stanchions, rendering the deck above of doubtful strength to withstand the shock and strain of a heavy sea boarding the vessel on that point—a thing not unlikely to happen in scudding. In the same part of the hull two reverse frames are stopped short, and a space of about 4 inches separates them from the reverse frame, continuing to the deck stringer above, thus weakening the frame at that important point.

In the after transom where the reverse frames are cut off the out frames have been connected by a floor plate.

The three beams here referred to as being unsupported by stanchions are of the steel T bulb pattern, 7 inches deep, and weigh 25 pounds per foot length. They are respectively $15\frac{1}{2}$, 18, and $19\frac{1}{2}$ feet long, spaced

14 inches apart, covered with 10 and 13 pound plating and 3½-inch :ing. They are situated next abaft the after collision bulkhead. deck-house covering the after hatch is one frame forward of this ikhead, and it is beyond a doubt that a sea which would sweep away ne house would not have the slightest effect on this deck, yet the house considered amply strong to withstand any weather. We consider stanchions quite unnecessary, and that the deck is amply strong to st seas boarding the vessel at this point, which rarely occur in the heaviest weather to a well-handled ship.

The reverse frames referred to as cut off were cut in accordance with the original plans for the location of the steering gear, and were not connected after the change in the steering gear. They are the reverse bars on the frame forward of the stern-post; they extend only 2 feet below where they are cut down into the run of the ship, and it would not have made the slightest difference, and the local stiffness which they assist in providing would be ample if they were entirely omitted below this point.

zenmast Step (Ad. p. 2). The angle-iron truss forming the support of the miz-st on the port side is too light for the purpose, and is also defective, having a lengthwise in its web for a distance of about 6 inches.

he step of the mizzenmast, which was weak and insecure by reason of defective port, has been strengthened to a degree promising perfect security.

These remarks are just, and we are at fault in not having discovered that only a single angle, and that a defective one, had been fitted where two were required by the plans. This stiffener, however, forms but a ll part of the step of the mizzenmast, which rests on the berth-deck al tie-plate, and is supported by the longitudinal shaft-alley bulk-head beneath.

SPEED.

Reliable speed is her first and greatest requisite for usefulness. She must be able to possess this quality in all weather and under all conditions at sea.

The law authorizing the construction of the Dolphin provided for a 'sea speed' of 15 knots per hour. A dispatch boat not having the ability to make that speed continuously in such weather as she may reasonably be called upon to encounter, would at this day not answer the purposes of the service.

The Board witnessed her performance on the smooth waters of Long Island Sound on three occasions. The conditions were most favorable, but the speed attained, making the proper allowances for tidal influences, was not in excess of 15 knots per hour, a result very far from promising a like speed on the sea under the conditions she must always be ready to meet in actual service; for in order that a vessel should keep up a sea speed of 15 knots per hour she should be able to make 17 to 17½ knots per hour in smooth inland waters like the sound.

Ad. p. 7. Second trial 12th May.

The speed made by the vessel could only be determined with approximate accuracy that part of the course between Execution Rock and Eaton Neck Light, and was follows, as shown by bearings and patent log:

eed per hour by taffrail log	14.5
ed per hour by bearings	15.5
Difference	1.0

But the difference in favor of the distance run per hour as shown by bearing can readily be accounted for by the effect of the fair tide, so that the speed registered by he taffrail log doubtless indicated the approximate speed given the vessel by the wer of the engines for the first hour of the run, during which hour, however, the nes were not worked up to their highest point of effort.

average speed for the entire run, but not possible to determine with the ap-mate accuracy obtainable with regard to the result shown during the first hour's was 14.8 knots per hour nearly.

taffrail patent log used was a new one of the American pattern, furnished from avy-yard, and there is no good reason to question its approximately correct registion.

Ad. p. 10. Sound trial 28th May.—Average speed as shown by patent taffrail log and substantially confirmed by bearings, 14.93 knots. But corrected for tide, 14.6 knots.

All conditions favorable: weak tide, moderate breeze to light, smooth sea and clear channel.

Ad. p. 11. Sea trial 11th June.—Average approximate speed as shown by patent log, 12.75. Approximate speed shown by bearings and influenced by fair tide, 13.6 knots.

All conditions favorable for trial—smooth sea, light breeze, and fair tide both ways—and in no sense could the trial be regarded as testing the sea-going qualities of the ship.

The speed being entirely dependent upon the design of the vessel was not included in any stipulations of the contract, and the whole responsibility for it rests upon the designers.

In our letter to the Department of 20th December, 1882, we stated that the dispatch boat should have a sea speed of 15 knots per hour. In designing the vessel and proportioning the power we regarded sea speed as that which the Dolphin would be able to make in fair weather for a continuous run of more than one day's steaming; in fact, we expected the Dolphin to make the trip from New York to Key West, say, at that rate in good weather. It is absolutely necessary to presume good weather for the speed performance of a ship, for a heavy head sea and a gale of wind, or any of the various combinations of wind and weather that can be imagined, cannot be regarded as proper circumstances for a basis for a design. To say that the Dolphin should make 17 to 17½ knots per hour in smooth water in order to make 15 knots at sea is a broad generality which does not accord with any design or calculation that was ever made on the new vessels, or other similar vessels with which we are acquainted. The present recognized standard of speed, and which we see credited to vessels of all navies, is that which they obtain by taking the second mean of four runs back and forth over a measured mile, the turns being made at full speed. This is the test to which we expected to subject the Dolphin after she was commissioned and fully equipped. The contract intrusted the Advisory Board with the conduct and regulation of the trials, and when the question of the preliminary trial came up for consideration we decided that the vessel should not be run over the measured mile in the light condition and a record of speed obtained which could not be again obtained at the load draught. We considered, and so stated, that the records of speed in the Sound were merely approximate and could not be regarded as speed trials; not only for the reason above stated, but that the method of taking the speed by sighting single points when they bear abeam, presuming a straight course, and using the best of taffrail logs, admit of errors which, when complicated by the unknown and indeterminate effect of tides and currents, makes the speed contain entirely too many elements of uncertainty. The trial over the measured mile eliminates many of these errors, and when carefully made it gives the most accurate measure of what speed can be obtained with a given power, and the custom is to make these trials at different powers and thus obtain a speed and power curve.

This we consider the only satisfactory method of measuring the speed, and by such a record our design showed that the Dolphin should make from 15.75 to 16 knots an hour for 2,300 I. H. P., at the load displacement of 1,500 tons with a clean bottom; the trials which the Board made on the Dolphin on November 20, making 15.3 knots at 1,279 tons with 1,954 I. H. P., and on March 10, making 15.16 knots at 1,300 tons with 2,118 I. H. P., leads us to believe that our calculations would be fulfilled, and that the sea speed of 15 knots would be obtained. The speed on long runs compared with that over the measured mile depends

h more on the maintenance of the engine power than the action of sea, and we consider that the requisite power can be maintained. s quite impossible to expect the Dolphin, with her present design, ıake 17 to 17½ knots, which would require 3,300 to 3,600 I. H. P., reas our maximum is 2,300. When we came to examine the records he speed made on these later trials of the Dolphin, they are in sev- instances so inconsistent with the statements made at the time of trials, and the corrections for tide are made in such an arbitrary ıner, that we hesitate to base any calculations upon them without a record of times and distances, readings of the log, and the assumed ections for tide. Again, we consider it an unusual thing to make itive statements in such an important matter as the speed of the phin from the results given by a single untested patent log. There matters, also, in the printed record which may be typographical rs, as they do not appear to admit of explanation. For the trial May 28, the speed is given thus: "Speed of patent log, as substanly confirmed by bearings, 14.93 knots, but corrected for tide 14.6 ts."

ow, we have reason to believe that the log actually read 15.5 knots the 6 hours. It then appears that this has, by some corrections not ed, been reduced to 14.93, and then, having presumably obtained proper speed through the water, or the true speed, it is further re- ed by a tidal correction of 33-100ths knots. We hesitate to say it intended to mislead, but it is certainly an entire novelty in naviga-

INDICATED HORSE-POWER.

ıe contract requires * * * that the ship's engines should in her trial trip of rs indicate 2,300 mean horse-power.

th regard to the stipulation as to horse-power, two unsuccessful attempts to ne Dolphin in Long Island Sound for a period of six hours were witnessed by this d. On the third trial the Dolphin succeeded in running the required six hours, subsequently made a fourth trial at sea from Sandy Hook to Barnegat Light ded to her sea displacement. The trip at sea, however, gave no test or her sea-qualities, as the water was as smooth as had previously been found in the

ı the first unsuccessful trip, for the period she was running on the trial her en- indicated a mean collective horse-power of 2,008. On the second occasion her crank-pin became heated, as previously stated, before the actual trial began, e third occasion her engines indicated for the period of six hours a mean collect- orse-power of 2,253; and on her fourth trial, the boilers making steam under l draught alone, the horse-power developed by engines and pumps was 1,648." all these occasions great efforts were made by the contractor and his men to the utmost power which could be developed. Her coal was of superior quality, ngines and fire-rooms in charge of regular engineers, and streams of water were laying on the journals to prevent heating; in short, her conditions in all re- were more favorable than those she can be expected to have when in service, lly when called upon to run day after day under the varying phases of the , sea, and weather and on the open ocean—the only test of real value in deter- ng the qualities of a sea-going vessel."

. p. 7, second trial, 12th May.

mean indicated horse-power developed by this partial trial averaged for :h high-pressure and low-pressure cylinders	1,998
lowers and pumps, approximately	90
Mean collective power	2,088
ighest number of revolutions per minute	78
owest number of revolutions per minute	68

est pressure of steam, 87½ pounds.

se data were determined by the experts ordered to assist the Board, and as all onditions of the trial were so exceptionally favorable for the vessel, the Board strained to believe that her engines will never develop the power for six consec- hours called for in the contract.

Ad. pp. 9 and 10, second trial, 28th May.

Highest steam pressure	pounds..
Lowest steam pressure	do....
Highest vacuum	inches..
Lowest vacuum	do....
Highest feed temperature	degrees..
Lowest feed temperature	do....
Highest number of revolutions	
Lowest number of revolutions	
Average:	
Highest horse-power by card	2
Approximate mean indicated collective horse-power	2

Ad. p. 11, sea trial, 11th June.

Highest steam pressure	pounds..
Lowest steam pressure	do....
Highest vacuum	inches..
Lowest vacuum	do....
Highest feed temperature	degrees..
Lowest feed temperature	do....
Highest number of revolutions	
Lowest number of revolutions	
Average number of revolutions	
Highest horse-power by card	1
Approximate mean indicated horse-power independently of auxiliaries	1

In reporting of the trial made by us on March 10, 1885, we that the mean collective indicated horse-power of the engin 2,118, and that there was a deficiency of 182 horses power less th 2,300 required by the contract; also, that in our opinion this defe neither due to defective workmanship nor materials, but that wi ter coal and a well-trained engineer's force the result would be exc This statement was meant to refer to the conditions which would on the second trial required by the contract, when the ship wa missioned and fully equipped; therefore it is gratifying to find tl the six-hour trial in the Sound of May 28, with superior coal, bu the same undrilled engineer's force, the results of our trial we ceeded in regard to the power developed by amount of 135; n from 2,118 to 2,253 I. H. P.—that is, the mean power developed per cent. less than the contract required. This result, taken wi fact that the engines and boilers were not pushed to their full ca would seem to indicate a thoroughly successful result, which we b it to be.

The statement of the examiners of the Dolphin that "great were made by the contractor and his men to show the utmost which could be developed" is not sustained by the steam-log of th for the case stands actually that the revolutions of the engines beginning of the trial were 73 per minute, and they gradually and ily increased throughout the run to 75 per minute at the end. The pressure remained very nearly constant throughout, but the blov assist the draft were run at only one-half power for the first fi of six hours of the run, showing that all the steam that was nee the desired piston speed was obtained, and that there was no w attempt to exceed it. In fact, we have reason to believe that tl tractor, in his excessive anxiety to give no chance for a recurre the hot journals of the two preceding trials, gave instructions tl full power should not be attempted. This we regret, for believin the ship is amply strong, and knowing that the parts of the journ pins are well-proportioned for higher speeds of piston, we think it were possible to heat the bearings merely by forcing the eng ought to have been done.

To run water on the cranks is a precaution adopted in all steamers running at high speeds. All the high-power Atlantic liners run water on the journals from one side of the ocean to the other, and we should never except to run a full-power trial of a new engine without water.

The remarks quoted above as to the favorable conditions of the trial, and that from the results of such a trial one cannot predicate the average performance in actual service under varying conditions of wind and sea, are gratuitous. We prescribed a certain standard trial for engine power and machinery performance of six consecutive hours in smooth water, one recognized by governments and commercial bodies throughout the world; we expected to measure the power and nothing more; the contractor does not supply sea-going qualities, nor is the six-hour trial to test them. The engines were designed to develop this power er these circumstances, but with, of course, due reference to dura-y; the last trial showed that the power fell 2 per cent. below our nate; we are not satisfied that this was the best performance even with the present screw, but we consider the result, as it is, one for congratulation rather than condemnation.

STEERING-GEAR.

The steering apparatus is not "strong" nor "easy of adjustment," and is not, in any way, "protected from shot." The lead of the wheel ropes is bad, involving needless chafe at many points, and, being exposed to the weather and constant wetting with sea-water throughout the length of the vessel from the stern to abreast the pilot-house, will be liable to speedy injury by rust. The 1-inch steel bolt connecting the wheel-ropes to the chain around the quadrant on the rudder-head by a composition attachment will soon be so corroded by the action of salt water as to render it useless or unsafe for purposes of adjustment. The device for releasing the chains when changing from steam to hand power, and vice versa, is crude and difficult of manipulation, and much inferior to the arrangements for like purposes on board the best ships of the mercantile marine of the present day. The wooden casing over the right and left hand screw-steerer and the grating platform surrounding the wheel and apparatus are of weak and flimsy construction, and the after frame of the steerer is fitted to the stern upper works of the vessel in a very unworkmanlike manner. There is no way to ship the tiller should such requirement arise except by the removal of the hand screw steerer from the rudder-head, together with its framing—a cumbersome detail at any time and a very grave matter to manage at sea in heavy weather. The tiller was not even on board ship, but the Board was told by one of the leading men or foremen of the works of the Messrs. Roach & Son that it was in the shop. The tiller was subsequently brought on board.

Ad. p. 4. * * * the board is of the opinion that the steering gear should have been so arranged as to have the wheel ropes lead under the main deck and carry a tiller as well as a quadrant or circle at its appropriate place in the after transom, and that the pilot-house should have been fitted with both steam and hand steering wheels, changeable from one to the other at a moment's notice, as provided on board merchant steamers of the best construction, and for such purpose the house should have been arranged and made larger if found necessary. With the small steering wheel now in the house there is not sufficient room to get around the chart table when working over a chart.

The steering-gear of the Dolphin has been the subject of much consideration and discussion by this Board, and though we believe it to be strong and efficient, there is no doubt but that it can be improved.

The various criticisms of the Board of Examination would not, however, in their entirety, produce a steering gear that would give perfect satisfaction to everybody.

The specifications for the steering gear of the Dolphin stated, "the steering apparatus throughout to receive the most careful attention in order that it may be strong, easy of adjustment, and, as far as practicable, protected from shot."

The latter clause referred to the original design of the steering gear,

in which the steering engine was in the engine-room and the power was transmitted along the orlop deck by a shaft and bevel gears. It is thus seen that the gear was partially protected from shot. No steering gear in a single-screw vessel can be absolutely protected. This is the proper way to arrange the steering gear, and is very nearly the plan adopted in the English navy, where the engine is usually either in the engine-room or on the orlop or berth deck, with shaft and gears to work the valves and tiller. This plan is far superior to anything suggested by the board of examination; but, unfortunately, from lack of space in the engine-room, it was found necessary to remove the steering engine from the engine-room, and, once out of the engine-room, no place could be found for it in so small a ship except under the pilot-house, which is the ordinary place for it in the merchant service.

The present arrangement is as follows: A small hand-wheel in the pilot-house actuates valves of the two-cylinder Sickles steering engine, placed directly beneath it, in a small separate compartment, in the house on the spar deck. The ⅝-inch chain passing over the sprocket wheel of the engine leads athwartships in an iron casing in the deck around a 12-inch brass sheave near the water-ways, beyond which it is secured to the 2¼-inch iron-wire wheel ropes which run alongside the hammock berthing, led over the 3-inch guide-rollers, taking the weight, and 3¾-inch guide sheaves at the slight deflection of the lead where it passes through the Hotchkiss gun towers. At the after end the wire rope is secured to a ⅝-inch chain, which forms a gun-tackle purchase, the sliding block of which is secured by a turnbuckle for taking up the slack and a tripping arrangement to a ¾-inch chain pendant which passes entirely around the wrought-iron tiller which forms a complete circle instead of the usual quadrant. In the forward quarters of this wheel are eyes for the relieving tackles and corresponding eyes in the sides of the ship.

This wheel, which was made extra strong, takes the place of the spare tiller. With the original steering arrangement there was a spare tiller, which is probably the one referred to by the Examining Board; but we are unable to see any use for it now, as there are at present four methods of taking hold of the rudder in order to control it.

The hand steering gear consists of the ordinary screw steerer, which takes directly hold of the rudder-head. It is furnished with a 5 foot 6 inch hand-wheel. The whole apparatus is of unusual strength; the main screw is 5 inches in diameter over all, the nuts are 9 inches long, and the connecting-rods 2½ inches diameter, with 16-inch arm, the diameter of the rudder-head being 6 inches.

The hand steerer aft has great advantages, as it has no connection with any wheel ropes whatever. We did have still another wheel in the pilot-house, as suggested by the Examining Board, but it was found desirable to change the connection of the steering-wheels with the engine; it was also found desirable to provide room for a new form of compass, lately introduced in the Navy. The hand-wheel was therefore left out. A chart-table in a convenient place is quite novel in the Navy, and the one in the Dolphin is doubtless open to criticism.

The present general plan of leading the wheel ropes is that common in the merchant service, and is to be commended for the ready accessibility of its parts. It usually gives satisfaction, but where there are large side and deck cargo ports on the upper deck, which would necessitate uncoupling the ropes when the ports are open, the plan recommended by the Examining Board is sometimes adopted. In the Dolphin, however, leading them under the main deck would have taken them through the coal-bunkers, engine and boiler compartments, where they

›uld have been very inaccessible, and a tube could not have been laid the Dolphin's deck.

It is not an unusual thing to connect a steel bolt to a chain by means a composition attachment, as it prevents sticking, and where not :tually lying in water and where ordinary care is taken of it, as there ;ht to be in this case, there is no danger of its becoming useless or ›fe.

ıne device for releasing the chains when changing from steam to hand ʳer is a simple trip-hook. It works very quickly when shifting from n to hand, which is the time when quickness is wanted, for there thing to do but knock the link off. When shifting from hand to n it takes longer, but there is very seldom so much necessity for e.

ıne strength of the wooden casting over the right and left hand w steerer and the grating platform surrounding the wheel and ratus is simply a question of opinion. We consider them of ample ngth; this applies also to the workmanship of the after frame of steerer.

INDICATOR AND ENUNCIATOR.

Ad. p. 2. The rudder indicator and enunciator required for the after bridge and :nunciator for the forward bridge are lacking. The after bridge is also unpro- d with sounding or speaking tubes.

The rudder indicator of the after bridge was not practicable after the nge in the steering gear from the original to the present plan, and, :fore, was not fitted. The enunciators were omitted by the Board, ıor this vessel the usual naval method of communication was pre- rred.

FREEING PORTS.

Ad. p. 2. The freeing ports amidships are so finished as to leave a water space 10 inches above the covering plates forming the bottom of the hammock nettings. port on the starboard side has a lower sill cemented on wood without any scup- or other arrangement for draining the water which in time will be likely to fill › space. The one on the port side was found to be uncemented, being simply closed th rough boards, but since the Board noted such omission the cement has been t in.

The freeing ports referred to as having insufficient protection against gment of water were originally intended for a 3-inch rifle howitzer, l during the construction of the vessel were used for the passage of ›oring chains while at the pier, and, as chafing planks were fitted ıpletely covering the sill, the cement was overlooked. The con- :tor has made good this defect, so that further comment is unneces- ry.

There is no water space under the sill of the freeing ports, as the ıole is filled with white pine and covered with cement.

CEMENTING.

Ad. p. 2. The iron work of the vessel "where water may be liable to lodge" has not cemented in all cases, as required by the specifications, and the painting in some -s has been neglected or slighted, as clearly shown by the rust observable on the l.

:garding the lodgment of water in different parts of the vessel, it ›cessively difficult to prevent it in every part without the use of › quantities of cement. The lodgment of water need not occur the vessel is in commission.

It might be expected that a certain amount of rust on the ' would be observed, inasmuch as some parts of the vessel have not repainted for a year.

Ad. p. 3. The seamen's water-closet lacks a full cement lining.

Two holes, about 3 inches in diameter, were cut in the cement l to rivet up a hammock-hook on the berth-deck and the workma neglected to repair the cement.

PLANKING AND CALKING.

Ad. p. 2. The planking of the main deck is not of the "best quality," knotty and shaky in parts, and not laid in the best manner, many of the wood bolts passing into the seams instead of into the body of the planks. The hatch coamings are too wide for good work and tightness, and the deck leaks f aft, as demonstrated by the rain-storm of the 1st ultimo.

Ad. p. 4. The sheathing of the chart-house deck is of inferior material and neatly laid.

Ad. p. 5. The ends of the planking on the berth and top-gallant forecastl are not nibbed at the ends of the vessel, as they ought to be to insure good wo strength.

Ad. p. 3. The planking of the berth-deck is of inferior quality, roug knotty in various parts, some places indicating sap, and calked in so poor a that the entire deck would leak like a sieve in case it became flooded with wat so damage or destroy the perishable stores and equipments stored below it hold, store-rooms, sail-room, bread-room, and the like. The Board was un find more than two thin threads of oakum in many of the seams, the specifi calling for not less than three threads, and it was an easy matter to pull the t out by the yard in various parts of that deck. Some of the seams in the ca not seem to have been calked at all, and none of the seams of that part of tl —cabin and ward room—laid with white pine, are painted, as required by the cations. Such was the condition of the deck until the 11th ultimo, when th found a large gang of calkers on board at work on it. One effect of this calk complete as it was, not extending into the wardroom, state-rooms, nor unde head sills, was to make it difficult to shut down some of the hatches, to splinter to some extent the under side of the deck, and to start or drive out the wood-screw fastenings. In its fastenings this deck shows grave defects, th screw bolts passing into the seams instead of into the body of the planks at points, and, in the opinion of the Board, the body can never be calked in a manner.

The planking of the decks was laid in March, 1884; the materia the best quality, and the decks at that time presented a fine a ance, but have since not received proper care from the contracto after the exposure to the trying temperatures of four seasons and steam heat during the winter, their appearance was not of the though we are of the opinion that the decks are good and se fastened, and will serve their purpose for years with the usual car are by no means in an unfit condition to remain in the ship, as t port would indicate.

It was no doubt the duty of this Board to see that the deck particularly the berth-deck, were recalked at the time of the accep but in the pressure of other matters this was neglected.

BUTT-PLATES ON BERTH-DECK.

Ad. p. 3. The butt-plates called for in the specifications to be placed und butt of deck-planking have not, so far as the Board could discover, been suppli this connection attention is invited to the contractor's explanatory letter of 1885, a copy of which is herewith appended, marked I.

These butt-plates are not of the slightest importance in regard strength of the vessel, as the deck is so cut up by bulkheads that are very few butts throughout the length of the ship. They

ted without our knowledge, and would have been required when it discovered soon after the deck was laid if it had been considered ssary. The decks are now stronger than the specifications would re, owing to the steel ledges and hatch-ties put in by the con-or.

COAMINGS AND HATCHES.

p. 2 and 3. Most of the coamings and hatches below the spar-deck, fore and ship, are made in a rough and discreditable manner, patched with batten , and in no way conforming to the specifications calling for "workmanship" of ost thorough character

ese coamings and hatches are at the present time in a bad condi- but were well made originally.

e excessive heat of last summer and the wear and tear from the al steam trials have been sufficient to produce the conditions ob-d. This work should be replaced where necessary.

HOLD FLOORS AND CEILING.

p. 3. The hold-floors do not conform to the specifications in that there are not ent arrangements for entering the bilges for cleaning and painting at all points ship.

e specifications with regard to hold-floors are not strictly complied Instead of shutters of two thicknesses, they are of one thick- They are supplied with lifting-rings, and the bilge is accessible o the bilge keelsons. Between the two bilge keelsons the ceiling e hold is solid, secured by bolts and nuts, and above the upper keelson cargo-strips are used. Within the coal-bunkers the flat ors is arranged similarly to that in the hold, and the balance of g is fitted and secured as per specifications.

BREAD-ROOM.

p. 3. The bread-room is not tinned throughout nor in a thorough manner, and perfect "water-tightness," as shown by the water-stains and rusted sheets of ne broken through) in its after part, all in default of the specifications. No gs had been fitted in the bread-room, but have now been supplied.

e object of tinning a bread-room is simply to keep out rats. The parts of the Dolphin's bread room not tinned are one end and part e side, both formed by steel bulkheads. The specifications do not re, nor has any attempt been made, to make the bread-room water- . If so, it would have been a water-tight steel tank with a water- door, whereas the door is of wood. The gratings for the bread- were fitted, but had been in some way misplaced.

TILING.

p. 3. The tiling on the floor of the cabin bath-room and water-closet is lack-

properly fit this tiling it would have been necessary to cut off the se angles of frames, which was undesirable at this part of the d.

nsidering this and the difficulty to be anticipated in the future in ing the tiling water-tight at this part of the vessel, it was decided it it. This change was inadvertently omitted in the letter to the rtment of April 20, 1885.

WATER-TIGHT DOORS TO DECK-HOUSES.

Ad. p. 3. The deck-houses are not fitted with water-tight doors.

The deck-houses are fitted, as required by the specifications, with closely-jointed doors, iron on iron houses and wood on the wooden one. They are precisely such as are customary in such places, and we are not aware that water-tight doors, such as are fitted in the hold, are ever required on vessels with high bulwarks, as in the Dolphin. It is also considered that it would be obviously inconsistent to fit water-tight doors to the houses where the hatches in the deck, with 12-inch coamings,, are fitted, as customary in the naval service, with tarpaulin canopies for ordinary weather, and with gratings so that the tarpaulins can be battened down in heavy weather.

Ad. p. 3. Bottle-racks in dispensary.

These were intentionally omitted from the vessel, as they would be required to suit the bottles when the vessel is commissioned.

PAINTING.

Ad. p. 3. The painting in the cabin and ward-room does not show "workmanship of the most thorough character;" it is inferior, and the gilded moldings called for are lacking.

The skin of the vessel has been repainted at various points where the skin was accessible; he hold store-rooms fore and aft have been freshly painted.

The ceiling of the deck is the only part of the wood-work in the cabin and ward-room which is painted, and that was carried out exactly as required and was considered when done as a neat, thorough piece of work; the gilded moldings were omitted by our instructions, as they did not correspond with the hard-wood finish.

JOINER-WORK.

Ad. p. 3. The bunk-boards in the state-rooms are fitted in a rough and careless manner, and some of the joiner work in the cabin and wardroom, and wardroom companion-way, cannot be considered, in minor details, as first-class work, especially as the bureaus in the state-rooms have no backs, the bulkheads being made to answer that purpose, a make-shift not known before in the naval service. The shutters do not seem strong enough to stand the hard usage of shipboard, and the state-room doors are not fitted with carrying rollers.

The wooden sheathing or ceiling of the sail-room is not carried up to the deck above to within 2 or 3 inches, leaving that space open for the access of vermin (rats) from the hold.

The joiner work of the cabins and wardroom of the Dolphin, which are finished in hard wood, is considered a handsome, workmanlike job; the minor details referred to seem to be not actual defects of bad material, joints, nor finish, but matters of opinion, for in regard to the details stated, our specific instructions have been followed—namely, the backs of the bureaus were omitted as they were to be fastened to the deck and fitted closely to the bulkheads in order to avoid the dirt-holes found under and behind bureaus as usually fitted in the Navy.

The state-room doors were not fitted with carrying rollers in order to avoid the rattle which invariably results from their use.

It is presumed that the shutters referred to are the sliding blinds over the air-ports. They are quite as strong as those fitted in railway carriages, and that would appear sufficient.

It would appear from the comments on the joiner work and other details that the whole was inferior to that usually fitted in the service;

eas the contrary is the case, and we are confident of the accuracy statement to the effect that the conveniences and accommoda- for both officers and crew in all respects as regards arrangements, s, and sanitary precautions, are far superior to any ship in the

HAMMOCK NETTINGS.

p. 3 and 4. The bottom boards of the hammock nettings are about 3 inches the level of the scuppers, making it impossible to drain them properly in case ter gets into them, and the bottoms are not cemented. The wooden moldings nettings are not of first-class finish, especially the end or upright moldings, are of soft pine, put on in the roughest manner. The top rails are not neatly ed in all cases, and forward of the nettings on the port side a graving piece of ne set into the rail mars its appearance.

bottom of the hammock netting is formed by the deck stringer s naturally below the level of the waterway and scuppers which iboard of it. It would have required 9,400 pounds of cement to the bottoms of the nettings up to such a height that they could ained into the waterways. It is considered that to expend this t to accomplish an object easily secured by the most ordinary care officers in charge would have been absurd. The bottom boards e nettings are loosely put in merely to protect the hammocks st the sharp edges of the steel angles and plates, and may be d at any desired height.

ARMORY AND STEERAGE HATCH.

p. 4. The armory is badly located and cramped for room in that it is put up on th-deck at the after end of the wing passage, and immediately adjacent to the e hatchway, which, from the closeness of the latter to the port gangway, will ly to be one of the wettest parts of the ship in bad weather. Seas coming over ngway would almost be sure to pour down that hatch, flooding the deck, in- g armory and wing passage space below.

armory consists merely of a set of covered racks for thirty rifles ayonets and thirty revolvers. In the ordinary acceptation of the there is no armory in the Dolphin, and there is no need of any. ontents of the rack would be stowed in an arm chest in any ex- linary weather when the steerage hatch was not closed; but as the object of this passageway was for communication through the n bad weather, this would not often occur.

LOCATION OF DYNAMO.

p. 4. The location of the dynamo, its engine, and switches of the electric light- paratus must be regarded as unfortunate, as being placed on the berth deck, e liable to be tampered with by evil-disposed men of the crew, especially as itch-board has not been guarded with a protection frame. In the opinion of ard, the after end of the engine room house might have been extended a little aft on the spar deck, so as to accommodate the apparatus without excessive to that part of the ship. So located, the apparatus would have been under of the officer of the deck at all times and more space been left for the crew on her cramped quarters of the berth deck.

p. 9. After nightfall the Board had opportunity to observe the working of the e lighting apparatus, when it became apparent that its machinery is cramped m, and that no provision has been made to protect the machinist in charge ccident when the ship is laboring in a sea-way.

l or rail should be put up parallel with the machinery to afford such abso- necessary safeguard, for, as now arranged, there is no point in the room which chinist can take hold of to prevent being thrown upon the rapidly moving en- y the rolling, lurching, and pitching motion of the vessel incident to service at The Board also noticed 2 or 3 gallons of oily water swashing about the deck of m with no means of carrying it off. The deck should be leaded and fitted with s, and provided with scuppers to run the water into the bilge.

The location of the dynamo and engine was a matter of serious co sideration by the Board. It was intended to locate it in the engin room, but it was removed on account of lack of space. The space no allowed is much greater than it ought to be, and is double what wou be allowed in a foreign man-of-war of that size. It was the intentic of the Board to put a search-light apparatus in the same compartmen but it had to be left out on account of the excessive space occupied b the incandescent plant. The difficulty is that no electric lighting com pany in the United States will put its dynamo and engine in the lin ited space that is ordinarily allowed in a foreign man-of-war or merchan steamer, and guarantee the work. This is well shown in the Trento and Omaha. It was the suggestion of the Bureau of Navigation tha the electric plant of the Dolphin should be placed on the spar-deck i an extension of the engine-room hatch; but on account of the weight the dynamo and engine and that of the extension of the house, and tl expense, it was decided by the Board to locate it in its present positio which is a compartment taken from the coal-bunker and not from tl berth-deck, though it opens into it. It is the custom of the service fo all electric apparatus to be under the eye of the navigator and not of tl officer of the deck. The suggestion of covering the floor of the dynam room with lead is a good one, though it would be better to tile it, as lead-covered floor would track foot-marks on the berth-deck. The su gestion of a hand-rail and a protective guard for the switch-board also good. A scupper leading the oily water to the bilge should on n account be allowed, as it is contrary to the best practices of the servic

AFTER-DECK HOUSE.

Ad. p. 4-5. The large house over the cabin companion-way is a needless incu brance, adding weight to the ship which could have been utilized to more efficie use elsewhere. It also takes up room better left for the work of the deck and t range of sight from that part of the vessel.

When the Dolphin is employed as a flag-ship, for which she is fitte this deck-house will prove to be a great convenience to the fleet offic as it provides a ready shelter from the weather, handy to the deck a after bridge.

SCUPPERS ON BERTH-DECK.

Ad. p. 5. The construction is also defective in not finishing the berth-deck wi water-ways and scuppers, the evidence of water collecting along the edges of t planking and bulkheads being already too apparent, as shown in the wing passage the berth-deck and under steerage hatch.

We were of the opinion when the specifications for the Dolphin we drawn that scuppers were impracticable, and water-ways unnecessa on the berth-deck of the Dolphin, and are still of that opinion. T deck is below the water-line, and scuppers could only lead into the bil and thus lead the ventilation from the bilge to the berth-deck, whi is now carefully conducted to the open air by valves in the spirketti of the spar-deck.

It should be remembered that the Dolphin has been completed 1 eight months, and does not receive the same care that she would in navy-yard or if in commission.

WATER-TIGHT DOORS.

Ad. p. 5. To avoid false closure of the water-tight doors, the door-clamps shou have been fitted with stops to prevent their excessive action in passing beyond point needed to effectively close the doors.

If the clamps are kept properly adjusted by the set-screws prov for the purpose, false closure of the doors will not occur.

SHELVING.

The galley-room and several of the hold store-rooms have no shelving.
The hold store-rooms have been fitted with proper shelving.

The hardwood drop shelf was fitted in the galley-room, and all store- (excepting bread-room) on forward orlop-deck and cabin-locker on after orlop-deck were fitted with shelves prior to March 10, 1885. S that date shelving has been placed in the ward-room, cabin, and master's store-rooms and awning-room at the actual expense to the tractor of $44.71.

BOATS, CARRIAGE OF.

Ad. p. 5. The present carriage of the boats just abaft the gangway is not good, for sea stowage fittings should have been provided to carry them on the rail or on light gallows frames.

The boats are carried and secured as is now customary in the Navy, but we are of the opinion that gallows frames may be better for the after boats.

BATTERY.

Ad. p. 5. In the matter of the battery, the construction of the vessel not providing for a fire directly ahead with the 6-inch rifle must be regarded as a grave defect. Carrying but one effective gun, the greatest all-around range of fire possible should have been arranged for.

The position of the 6-inch gun is that usual for a single spar-deck pivot-gun in the United States Navy and all other navies; but its train is rather greater, being from 70° forward of the beam to 63° abaft the beam on each side.

The gun is too heavy to mount either under the forecastle or on it or on sponsons on the side of the ship. It represents with its carriage and attachments a weight of 24,343 pounds, with a vertical thrust, when fired, of 40 tons. Sponsons would be so large that the lower portion would interfere greatly with the ship's progress in a seaway. To leave the Dolphin without a forecastle in order to get right-ahead fire would not be advisable in a dispatch boat, though most admirable in a vessel of the Boston and Atlanta type. Re-entrant ports are unadvisable in a vessel so fine forward as the Dolphin, as they would cut away a large portion of the present main deck, extending almost forward to the forecastle, and would impair the seaworthiness of the vessel.

The Board dissents from the opinion that the Dolphin possesses but one effective gun. The tendency of modern thought is distinctively and decidedly in favor of the great value of machine-gun fire, and the Dolphin is, therefore, supplied with two 57^{mm} rapid-fire single-shot Hotchkiss cannon and four 47^{mm} revolving Hotchkiss cannon, calibers which have never been mounted in our Navy. The two 57's are mounted on the top-gallant forecastle, where they sweep two-thirds of the horizon, firing 16 to 18 6-pound steel shell per minute, which can pierce a $4\frac{1}{4}$-inch steel plate at the muzzle, and a 1-inch steel plate at 4,000 yards.

Two of the 47^{mm} revolvers are mounted in steel towers on the sides, just abaft the 6-inch gun, and have a range of fire from directly ahead to 80° abaft the beam. The other two are mounted in similar towers abaft the midships, and have a range from right astern to 80° forward of the beam. These guns throw a projectile weighing $2\frac{1}{2}$ pounds at the rate of 44 per minute, having a proved destructive range of 4,000 yards and a penetration of $1\frac{1}{2}$ inches of steel at 300 yards.

Although the extreme range of all modern ordnance is very great, the practical fighting range at sea does not much exceed 2,000 yards, and any shot from the Dolphin would penetrate an unarmored vessel at that distance.

In the light of the experiences of the bombardment of Sfax and Foo-Chow, to be found in the reports of the Intelligence Office in the Navy Department, it is believed that there are few naval officers who would criticise the Dolphin as possessing only one effective gun.

PIN RAILS.

Ad. p. 5. The pin rails have not been bored for belaying pins.

Because the Department furnishes the pins and the rails are to be bored to suit them.

AWNING STANCHIONS.

Ad. p. 5. The awning stanchions are not galvanized.

These stanchions were not galvanized in accordance with our instructions, as it was considered desirable to paint them.

ENGINE-BED PLATE.

Ad. p. 5. The engine-bed plate was designed to be supported on a wooden bed plate laid between the engine foundation and bed plate, through which bolting passes for securing them together. Each bolt was to be fitted with an iron filler in lieu of the wood, to make solid bolting; but the examination showed that some of the bolts lack such appliances, leaving to the wood alone the strain imposed by the working of the engines, the ultimate effect of which would tend to the loosening of the main connection and support.

If it were true that this method of fitting the engine bed plate resulted in a loosening of the fastenings of the engine to the hull, this would be a serious imputation as to the design and construction of the machinery. But this is far from being the case.

The specifications do not require horseshoes or fillers around any of the bolts; the contractor added them, however, for more than half the bolts. It is not at all at variance with established practice to set the engines on a layer of hard-pine wood, and many of the most powerful engines in our merchant vessels are fitted in this way without the use of iron fillers.

That the Dolphin's engine is most securely fastened is well illustrated practically by its so well withstanding the strain put upon it by the rupture of its shaft at nearly full power. The most minute examinations of the machinery immediately afterward, and carefully repeated since its numerous trials, fail to give the slightest indication that its strength and fastenings are not all sufficient to endure, for continuous service, the greatest strains that the full power of the engines can put upon it. The bed plates are secured to the keelsons by 80 bolts of $1\frac{3}{4}$-inch diameter, spaced from 13 to 18 inches from center to center.

It requires no special professional knowledge to see that the cast-iron bed plate, which is of the usual form used in vertical engines, carrying the cylinders and forming the pillow blocks of the crank-shaft, and is a casting in the form of a longitudinal and transverse box frame, viz, 24 inches high and 10 inches wide, with walls $1\frac{1}{4}$ inches thick, and having bottom flanges, 5 inches wide by $2\frac{1}{2}$ thick, running all around the box frame on both sides, could not bend so as to effect the crank pins and cause their heating. The heating of this pin was unquestionably due

: fact that the journal cap was screwed up too tightly. Before ;on the trial this cap was removed for an examination of the crank ,nd in replacing it the brasses were screwed up together too tightly; s simply this error, liable to happen to the most careful of engi- . Previous to this the pin had always worked well, and has since nued to do so.

SHAFT ALLEY.

p. 5. The supports to the shaft alley are not first-class in workmanship, the and brackets not being properly cut to fit down on the frame of the vessel so ;ive the best support.

: support given by any bracket or angle is not that derived from ıg it to fit so that it takes weight on its edge, or end; in fact, the best workmanship, in all structures rigidly secured by rivets, : the strength is merely that of the fastenings, is to provide simply ient metal to take the fastenings. Therefore, in shaft brackets, as ıer places, we regard the workmanship as good and the structure g.

ENGINE-ROOM FLOORS.

p 5. The engine-room floors cannot be regarded as of first-class workmanship :cessary convenience.

s allegation, that the engine-room floors are neither first-class in manship nor convenient, is not sustained by facts. Though the ron corrugated or grooved flooring presents a better appearance makes a surer footing) than the wrought-iron plates with which 'olphin is fitted, the latter were required in order to save weight, :y are much lighter per square foot than the cast-iron plates, and ıse they are more durable. It may be well stated here that it is ɔy a careful scrutiny of the weight of such small details that the ıts of the machinery have been kept down and now stand at con- ıbly less than the original estimate.

SHAFTING.

pp. 5 and 6. The steel shafting called for in the contract broke on the first ip proper of the vessel; the contractor furnished another shaft of the same ma- constructed under the same faulty process as the first one, but the tests applied new shaft not being satisfactory to the Advisory Board the contractor was per- to substitute iron shafting in its stead; and it would seem that the extra ex- nvolved in the change, including the tests applied to the new shafting, and further determined the action of the Advisory Board with regard to the shaft- the Atlanta, Boston, and Chicago, the removal of the prior shafting and put- . of the iron one, together with the cost of the necessary cutting away of the and planking on the berth and main decks, and the enlargement of the stern her bearings to take the larger diameter of the iron shaft, has been charged to :ount of the Dolphin and against the Government. The Board is of the opin- good and safe steel shafting, slightly modified from the specifications and ,s furnished the contractor, of the diameter required (13 inches), could have ɹde in this country; and the cost of all shafting supplied the vessel, together ɹe incidental expenses connected with the removal of the broken shaft and the g in of the new one, should have been borne by the contractor.

s statement in regard to the change of shafts is so misleading and ect that it seems best to make a clear, full statement of the whole r.

ı thrust length of the steel shafting required by the specifications on the trial of November 20th; the contractor immediately or- another steel shaft, which was inspected and tested by the Board jected on account of the great deviation from the required limits

of strength. After the shaft broke the contractor and the manufacturers of the shaft alleged that the failure was due to the design furnished by the Board; the contractor protested against the use of the remaining lengths and urged us to condemn them and recommend that the Government should replace them at its own expense; this the Board declined to do, believing that the failure was due to faulty workmanship, and not to the error in the design, and in any case would not take action without full actual information in regard to the conditions of the other shafts. Tests were, therefore, undertaken by cutting up and testing material for the broken shaft and trepanning the ends of the other lengths. While this was going on the thrust length was rejected, and although we believed that good steel shafts could be made in this country, it would take some time to actually determine the proper tests of strength and mode of manufacture, and, to avoid further delay in the completion of the vessel, we recommended that the contractor be allowed to put in an iron thrust-shaft; this he did entirely at his own expense in every detail. During this time the tests of the remaining length of steel shafts proceeded, and the results were such as to lead the Board to decide that, though we had not sufficient information to condemn them, none of the steel shafts should be used, unless they could be actually submitted to a twisting stress sufficient to prove them. It was found that this would subject the vessels to great delay in completion; therefore the Board recommended action that was approved by the Department, in the following terms:

"The contractor may put into the vessels iron shafts of approved manufacture, and if they stand during the trial trips and final trials they shall be accepted as a satisfactory fulfillment of the contract. The contractor shall allow the Government the difference between the cost of making the iron and steel shafting. The steel shafting shall be subjected to all reasonable tests for determining its strength; and those parts which stand such tests shall be taken by the Government and paid for as duplicate shafting at their cost to the contractor. If any parts are broken by reason of any extraordinary tests which could not fairly be insisted on for proof, considering the existing condition of steel manufacture in this country, the Government shall also pay the c[ost] of such parts."

This is the agreement that has been carried out on the Dolphin, and is being carried out on the other vessels.

In executing this agreement on the Dolphin the details were equitably arranged with due regard to a just interpretation of the contract. In the case of the Dolphin the shafts were completed, fitted, and in the ship, and had been tested by us at the contractor's expense under the terms of the contract. The tests now proposed were extraordinary and could not be reasonably required under the contract; therefore we recommended that the Department pay for these tests, and that as some of the shafts had to be taken out for the purpose, we also recommended that the Department pay half the expense of cutting the decks necessary to this removal, the contractor bearing the other half, as he had to pay the expense of removing and testing the broken shaft. We also agreed that the Department should pay the expense of removing and testing the steel shafts. The iron shafts put in were of larger diameter than the steel ones, and necessitated changes in the bearings and other parts of the ship which had been completed in accordance with the contract; therefore we agreed that the contractor should be compensated for the changes in these parts. We prescribed the tests referred to, that the steel shafts should be subjected to—a twisting stress equivalent to twi[ce]

the mean twist of the engines at maximum power. In all these matters of expense we made the estimates with the utmost care, and the account with the contractor stands thus:

Cost of changes in work already done		$734 00
Excess of cost of steel over iron shafts	$248 26	
Trepanning and other tests of steel shafts		978 85
Docking to remove steel shafts		920 07
One-half cost of cutting decks to remove shafts		547 50
		3,180 42
		248 26
		2,932 16

The estimated actual cost of the steel line-shafting, which has to be for if it passes the test, is $3,910.56.

COMPARTMENT PUMP.

Ad. p. 6. A compartment pump supplied to the vessel proved to be larger than was necessary. This pump was removed to be used on the Chicago, and a second smaller one was put in its stead, the cost of which was charged to the Dolphin. redit seems to have been given the vessel for the pump removed.

The facts of this matter are as follows, and show that neither has the Government been the loser to the slightest extent nor does any unjust or unfair charge remain against the Dolphin: When it was decided that the large pump supplied under the contract for the Dolphin should be discarded, it was found to be of the same size as are required the Chicago, but not yet purchased by the contractor; it was there- turned over to the Chicago and a credit obtained on the contract vessel of $1,062.50. The second or smaller pump for the Dolphin chased for the Dolphin by the Bureau of Steam Engineering, charged to its own annual appropriation, "Steam Machinery." The first pump later proved unnecessary on the Chicago, as it was found desirable to supply two pumps of the same collective capacity as the three at first required, and consequently the third pump was turned over to the Bureau of Steam Engineering. All this was done with the full knowledge and approval of the Department.

AIR-TIGHT FIRE-ROOM.

The contract, among other things, provides that "provision be made for closing the fire-room hatches and other openings sufficiently tight to maintain an air pressure equivalent to a head of water of 1 inch in the fire-room."

With regard to (this) stipulation, no attention seems to have been given for its proper observance, the contractor alleging that such pressure had been obtained on the first trial witnessed by the Advisory Board by using tarpaulins to cover the hatches, but, owing to changes made by the Board with regard to blowers, he could not now get the pressure.

It is only too evident that such an alleged contrivance was but a makeshift at best and could be of no practical value.

Ad. p. 7. No arrangements were apparent for securing the air pressure in the fire-rooms as required by the terms of the contract, *i. e.*, "an air pressure equivalent to a head of water of one inch in the fire-rooms," and when the contractor's attention was called to this point, he stated that such pressure had been obtained on the first trial of the ship witnessed by the Advisory Board, by covering the hatches with tarpaulins, but owing to changes made by the Advisory Board he could not now get the pressure. It is needless to say that the air pressure demanded by the contract could not be obtained by any such contrivance as the contractor alleges was used on the occasion of the first trial witnessed by the Advisory Board. On this provision of the contract the efficiency and safety of the vessel might depend in a great degree in cases of emergency.

In the original design of the Dolphin no special arrangements were made to provide air-tight fire-rooms; the maximum power of the engines was based upon a consumption of 20 pounds of semi-bituminous coal per square foot of grate per hour, which it was expected could be obtained with natural draught, assisted by the ship's ventilating fans; in case, however, that this should not prove sufficient, the precaution was taken to insert in the specifications the provision in regard to air-tight fire-rooms.

On the first trial of the Dolphin, in Delaware Bay, the draft was found insufficient, and temporary provisions was made to try the effect of making the fire-rooms air-tight; the result was such that it was regarded impracticable to attempt to make the fire-rooms air-tight either at the level of the top of the boilers or by making the deck-house doors and hatches tight.

It was therefore decided to use open fire-rooms and supply blowers of sufficient size to furnish the necessary draft, and this has been done. Although we do not regard the location of the blowers as the best that could have been devised, still it has been carried out in accordance with our instructions, and they work well. A more careful examination will show that attention has been paid to the matter of forced draft by the fitting of dampers, now removed, in the ventilators, ash-chutes, and uptakes.

STEAM TURNING GEAR.

Ad. p. 8. And here one great defect in the ship's steam-working gear became but too apparent, for while the vessel has twenty-three separate engines on board, no provision has been made for turning the engines by steam power when the main engines are disabled, and instead of the less than five minutes that ought to have sufficed for the turning of the engines into position to enable the crank-pin and brasses to be overhauled, it took one hour and a half to effect that purpose, although only a quarter of a turn of the engines was required and made.

It is quite true that there is in the Dolphin a large amount of machinery, probably much more than any vessel of the size in this country. The turning gear of the main engines received due consideration, and, as it was not regarded as essential to furnish it with steam-power, an additional engine was avoided. It may be noticed, however, that the Chicago, Boston, and Atlanta are the only vessels in the Navy fitted with steam turning-engines.

In making up the list of "twenty-three separate engines," we are compelled to conclude that the computers have counted each of the cylinders of the main engine as an engine, as well as each cylinder (4″ by 4″) of the two double-cylinder ash-hoisters; also each cylinder of the two cylinder engines for the windlass, steerer, and the feed-pumps as a separate engine. This is a full but not a fair count, for it leads one to believe that there is an engine for each of twenty-three distinct functions.

SWIVELS ON WINDLASS.

Ad. p. 8. In weighing the anchor the Board noticed that when a swivel of the chain reached the barrel of the steam windlass the grip was not good, and that recourse was had to a preventer rope before the swivel could be made to bite and pass abaft the barrel. Such defect would be likely to prove a serious matter in lifting the anchor in rough water. The slipping and surging of the chain under such circumstances would be apt to snap it.

In the Navy it is customary to fit a swivel at every other length of the chain. The wildcat of a windlass cannot be made to work efficiently where these swivels are employed; therefore, when we discovered this matter some months ago, orders were given to omit all swivels in the

ains except the one about two fathoms from the anchor. This was to done for the Dolphin when she reached the navy-yard, as the chains ere supplied by the Government.

GENERAL DESIGN OF MACHINERY.

Ad. p. 9. And here the Board takes occasion to express the opinion that the ennes and machinery generally are of such inconvenient design and so inconveniently cated and arranged as to require much more than the usual number of engine and e room force to properly attend them. In fact, the force needed will doubtless be large for this little ship as is required to care for the engines and dependencies of uch larger vessels of the naval service.

The vague imputation that the engines and machinery are of such nconvenient design and so inconveniently located and arranged as to equire much more than the usual number of engine and fire room force o properly attend them is not sustained by the examination of the acts.

The engines differ but slightly from the usual type of vertical inverted ngines, and their arrangement affords unusual facilities for making very part accessible while the engines are in motion and for the usual xaminations and repairs.

The arrangements of air and circulating pumps and separate feed umps are, in our opinion, an advanced step in engineering, and the esults of their various trials not only proved their good working in ractice, but the per cent. of power absorbed by this auxiliarymachinry is less than the practice of ordinary engines.

It is not practicable in the dimensions of breadth of the ship to contrate the grate surface in one fire room and retain the wing passages. arrangement of blowers could be better, but this was shown by the lt of experience, and regarding the statement "that the force needed m doubtless be as large for this little ship as is required to care for engines and dependencies of much larger vessels," it is a matter of t that, with the exception of the Trenton, 3,900 tons, this little vessel 1,500 tons has more power than any vessel in the Navy. The engieer force in our service will probably be in proportion to the horseower, as it is in the English navy.

It is to be borne in mind that, for the power indicated, the Dolphin's hinery occupies no more space than any inverted direct-acting ouble-cylinder engine in the United States; also, that the indicated o power per ton weight of engine is greater than any similar maiery in this country, and indicated horse-power developed per square oot of grate exceeds any data obtainable from any American vessel, xcepting an exceptional small yacht or torpedo-boat.

LINK-MOTION.

Ad. p. 10. Sound trial, 28th May.
Link-motion defective, having too much jar.
Ad. p. 11. Sea trial, 11th June.
Link-motion still defective.

It might be supposed from the above remarks that there was some ssential fault in the link-motion, which is, however, similar to hundreds f others, and though it has a disagreeable jar, due to the method of port and the arrangement of the reversing gear, it properly performs ts duty in the regulation of steam and exhaust.

Board of Examiners to the Secretary of the Navy.

WASHINGTON, D. C.,
July 31, 1885.

HON. WM. C. WHITNEY,
Secretary of the Navy,
Washington, D. C.:

SIR: The Board of Examination has before it the criticisms of the Naval Advisory Board of the 13th instant last, with regard to the steam dispatch boat Dolphin, and begs to transmit the following brief reply:

The Advisory Board has taken fifteen printed pages to show that the Dolphin ought to be "a strong, staunch vessel"; that is, that the plans provide for a vessel of sufficient strength.

Their reasoning is elaborate, and their defense of the vessel and her builder as good as could be made under the circumstances, but from some of the facts stated by them we draw very different conclusions.

As stated in its report of examination, this Board is satisfied that the strength of the vessel can be shown only in one of two ways—tear her to pieces or send her to sea in heavy weather. If the supervision and inspection of the workmanship and materials exposed for its examination can be taken as a criterion by which to judge the frame and its fastenings, no amount of plans and specifications, and no argument, no matter how full of quotations from the "Proceedings of the Institute of Naval Architects," can make her strong and staunch. We agree with the Advisory Board that she should have been strong and staunch; but we are of the opinion that many of their departures from Lloyds were not calculated to produce those desirable qualities.

When the Dolphin was docked after her so-called sea trial, she showed unfair lines on some parts of her bottom, and several plates being removed to be strengthened, a curious condition was disclosed, and well worth the serious attention of those responsible for her inspection. Some of the spaces between her frames were found to be covered to a very considerable thickness with a conglomerate formed of chips, ashes, and dirt of various descriptions, and on top of this undesirable coating for steel plates the cement was laid. After the plates were removed it took some time to dig out this dirt, which was in some places moist and mucky, in order to break through the cement. Whether the bottom is in this condition fore and aft can only be determined by taking up the cement and making thorough examination.

The criticism of this Board was generally addressed to the fact that she is weak structurally without regard to what she ought to have been by her design, and it is stated that she showed weakness beyond what would properly be attributable to her plans. The Board of Examination is still of this opinion.

The heating of the journal upon the second unsuccessful trial the Advisory Board say was due to the tightening of the brasses. Upon what authority this statement is made they do not say. As the persons signing it, with one exception, were not present at the trial, it can hardly be put forth as of their own knowledge. The Board of Examiners assert the contrary to be the fact from information carefully obtained at the time from both the contractor and the persons in his employ who had charge of the machinery. The engines had been running steadily and satisfactorily at the dock for many hours after the journal-cap was

crewed on before the ballast was shifted, and no signs of heating; but n a short time after the ballast was shifted, and without any change n other conditions, except that the vessel was steaming up the Sound n perfectly smooth water, the heating took place. After the weight vas removed she made her third trial without the difficulty previously xperienced.

It was of the opinion then, and the Board of Examination is still of he opinion, that the extra weight and its distiibution caused the heatng of the journals.

When indications of weakness appeared to it, the Board requested of he Secretary a trial at sea. The Advisory Board, on page 8 of their itement, seems to admit the wisdom of this request, suggesting that hey are "well aware that there is nothing more certain to bring to light any latent defects which may exist in a vessel, either local or structural, than heavy weather at sea, and that under these conditions weakness may develop itself in ships which appear to be strong and well built." In answer to its request for a sea trial the Secretary advised it that under the contract the conditions of the trials were left to the Advisory Board largely, and that he doubted his power to exact a trial, the Board having fixed Long Island Sound as the place of rial. He subsequently informed it that he had requested the Advisory rd to unite with him in requesting a sea trial, but that they had fused. It was therefore obliged to take what it could get—a six-hours' run in smooth water under the New Jersey shore—no test whatever.

LOCAL WEAKNESS—THE BOW.

It specified that the bows of the ship were weak. The Advisory Board expresses the contrary opinion, but admits that "a short angle-iron stiffener was shown on the original drawings about this location, but it became inconvenient to fit it." The Advisory Board also says: "The only case in which the vertical plate-brace, fitted by the contractor in deference to the opinion of the examiners, will be of any value would be to erely stiffen the side when veering to the chain." It is stated that special weakness was observed, which must be merely a matter of inion, as there is not the slightest evidence of weakness, although the Dolphin has been at anchor many times."

The "examiners" never mentioned the subject of the weakness obrved in the bows of the Dolphin to Mr. Roach, or any of his people, but some of them were present when the examination was made. The Board had no authority to ask or authorize any changes, and the vertical plate-support was put in by Mr. Roach in "deference" to his own nion or that of his advisers. If, however, it serves to stiffen the sides when veering to the chain, it will have accomplished a most derable end. It is true, as stated by the Advisory Board, that the Dolin has been at anchor many times—at least a dozen—always in smooth iter, and her bows have shown no weakness. The Advisory Board n hardly be serious in suggesting that the strength of her bows has is been tested.

The Board of Examiners stated that the water-tight covers on hawse- are roughly made and of insufficient strength. The Advisory rd replies that they "answer the purpose," and "that it is not essary that they should be always perfectly water-tight." How they pose to make them water-tight when she needs them is not stated.

LOCAL WEAKNESS—THE STERN.

The Board of Examiners commented on the fact that two reve frames are cut off and a space of 4 inches left without any appar cause, thus weakening the frame. The Advisory Board states tl they were "cut in accordance with the original plans for the locatio the steering gear, and were not connected after the change in the st ing gear," showing negligence in some one, poorly supplied by the o ion of the Board that the ship is sufficiently strong even with cut fram The "examiners" never authorized the contractor to remedy this we ness, and it must have been done in "deference" to his own professio opinion or that of his advisers.

The Board of Examiners commented on the fact that "the angle-i truss forming the support of the mizzen mast on the port side is light for the purpose, and is also defective, having a split lengthw in its web for a distance of about six inches." The Advisory Board plies that "these remarks are just, and we are at fault in not hav discovered that only a single angle, and that a defective one, had b fitted when two were required by the plans." But no explanation given of such an oversight. It was, however, made good presumal in "deference" to the professional opinion of the contractor.

The Board of Examiners commented on the fact that three beams the after transom were unsupported by stanchions. The Advis Board replies that "we considered the stanchions quite unnecessa and that the deck is amply strong to resist seas boarding the vessel that point, which rarely occur in the heaviest weather to a well-m aged ship." This could hardly have been the view taken by the Bo when making the designs where the stanchions are indicated. Bei on the plans the Board of Examiners expected to find them, and are the opinion they would be of service in this as in other vessels wh are no doubt well handled in heavy weather.

The Advisory Board concludes its criticisms of the Board of Exa iners' report of the speed of the Dolphin in the following langua "Now we have reason to believe that the log actually read 15.5 kn for the six hours. It appears that this has, by some corrections stated, been reduced to 14.93, and then having, presumably, obtai the proper speed through the water, or the true speed, it is further duced by a tidal correction of 33-100th knots. We hesitate to sa was intended to mislead, but it is certainly an entire novelty in navi tion." After a careful review of this part of its report, the Board Examiners fail to find any novelties in navigation involved in its cal lations, and are quite certain that the Advisory Board would have b safe in assuming that there was no intention to mislead; and, furtl it stands prepared to show conclusively that the speed of the Dolp was as indicated in its report.

SPEED.

The Naval Advisory Board says that the method of obtaining speed, complicated by unknown and indeterminate effects of tidal c rents, makes the speed contain too many elements of uncertainty. ' method used by the Examining Board was that of the Advisory Boa and the results, though not exact, show that the speeds reported w not exceeded. The Advisory Board places sufficient reliance on si lar determinations to base upon them the opinion that the stea would make 15 knots sea-speed; that is, would steam from New Y to Key West, at that rate, in good weather, at a displacement of 1,

ons, though the Advisory Board's own reports show mean speeds not xceeding 15.3 knots at a displacement of 1,300 tons. The most favorble report of the Advisory Board is made for a displacement of only ,279 tons when, in smooth water, in Long Island Sound, "the boilers urnished ample steam," and "the Board estimates that the speed hrough the water for one hour for which more accurate observations rere obtained, was at the rate of 16 to 16¼ knots." The Advisory Board emarks that it is unusual to base statements in regard to so important atter as the speed of the Dolphin on the record of an untested taffail log. The records of the taffrail log in the trials made by the Examning Board were found to present some anomalies which gave sufficient eason for throwing the results given out of the report. A careful examnation of the log used in the trial of May 28 was made by the maker, who reported that it indicated too high a speed. In cutting out the record of the taffrail log, the figures expressing the speed shown by it were taken out, but the heading, "average speed shown by patent taffrail log," was accidentally confused with the following one, which referred to the mean speed for the whole trial, as found by comparisons of the number of revolutions made by the screw between certain points with the total number of revolutions made during the trial. As the distances between ints taken gave the speeds over ground, a correction was made for he effects of tidal currents which was sufficiently liberal towards the amer. In offering an explanation of how these estimates and corrections were made, a method is described which is entirely due to the enuity of the Advisory Board, and is "certainly an entire novelty navigation," as the Advisory Board states. The fair inference from heir criticisms on this important point—speed—is that their interpretation of average sea speed is not average speed at sea in all weathers, but a long run, say from New York to Key West, in good weather, and they express the opinion that the Dolphin will make an average of fifteen knots on such a trip. This Board confidently states that this was not the interpretation of average sea speed by the law-makers in providing money for the construction of this vessel, and it is not its interpretation of it. It believes, in view of the trials it witnessed, as also from the statement made to it by the "contractor, that he considered her a thirteen-knot boat;" that she will never, in actual service, th the present screw, sustain a speed of fifteen knots at sea in good bad weather. This Board recited the efforts of the contractor to make machinery develop the minimum requisite of 2,300 indicated horsepower, for six hours, and his failure to do so, and expressed the opinion that "her engines will never develop the power for six consecutive ours called for in the contract." In reply, the Advisory Board says, "the engines and boilers were not pushed to their full capacity." * * "We have reason to believe that the contractor * * * gave nstructions that the full power should not be attempted." To those who witnessed the efforts to make her indicate the power called for and necessary for her acceptance, this statement hardly seems serious. It s not the 2 per cent. deficiency that of itself is important, but the 2,300 as supposed to be the minimum limit, and she should have easily made and the margin of power should have been above it. We read of essels built for other Governments by contract, making from one to knots above the contract speed.

This Board is of the opinion that the engineer and fire-room forces on y on board the Dolphin during these trials can never be excelled, if er equaled, in the naval service. To say that the contractor did not his best to develop the highest attainable horse-power and speed ould be to impugn his good sense and business methods.

STEERING-GEAR.

The objection made by this Board to the steering-gear is substantially admitted, but followed by the gratuitous statement that "the various criticisms of the Board of Examination would not, however, in their entirety, produce a steering-gear that would give perfect satisfaction to everybody." The Advisory Board seems to have misunderstood the duties of this Board. It was not ordered to design steering-gear for the Dolphin. Had it been so, its report would have been differently expressed. It seems by the original plan the steering-engine was to be placed in the engine-room, but the engine-room being too small, it could not be placed there, and was finally lodged under the pilot-house, a fair and tempting target for machine-guns and small arms.

The Board criticised the pilot-house as too small, &c. The Advisory Board admits the correctness of this, but only explains it on the ground that it was so designed, and further says that, "a chart-table in a convenient place is quite novel in the Navy, and the one on the Dolphin is doubtless open to criticism."

But the service was promised and expected many novel things in the new ships, among them pilot or chart houses of sufficient room for steering-wheels, compass and its binnacle, and chart-table. It would seem that the Dolphin's pilot-house was not built large enough to accommodate the compass and its compensating binnacle built for it, though that binnacle actually requires less space than the binnacles in general use in the service. The use of a box on a shelf to carry a binnacle is a contrivance not known to any naval vessels except tugs, nor is it known to the best merchant steamers of the day.

This Board found and reported that the rudder indicator and enunciator for the after bridge and the enunciator for the forward bridge had not been supplied. The Advisory Board admits that this is so, throws part of the blame on the unfortunate steering engine, and disposes of the rest by stating that they considered the usual naval method of communicating preferable. This Board is of the opinion that the "usual naval method of communication" is very defective.

The criticism of the Board on the freeing ports is answered by the Advisory Board with the statement that "the contractor has since made good the defect." Many other criticisms are answered in the same way, while many are unnoticed.

This Board stated that the seamen's water-closet had not been cemented as required by the contract. The Advisory Board answers that "two holes, about three inches in diameter, were cut in the cement lining to rivet up a hammock-hook on the berth deck, and the workmen had neglected to repair the cement." This carelessness on the part of the inspector would have soon caused trouble, supposing only three inches of the lining exposed, but when this Board made its inspection not half of the surfaces to be cemented had been so treated.

In answer to the criticism of this Board on the planking and calking, the Advisory Board replies that though the decks had been disfigured and marred by the weather since being laid, yet they are of the opinion that the material was originally good and the work properly done, but they "have not received proper care from the contractor."

This Board, under its instructions, has not felt at liberty to fix blame upon anybody, though in view of the rough character of the work and the lack of preservative care that impressed the Board at the outset of its examination, the question frequently suggested itself as to what had been the duty and work of the officers under the direction of the Advisory Board, denominated as inspectors of hulls?

This Board again asserts that the material was not of the best, and hat the decks never were either properly calked or fastened. Only two all thin threads of oakum were used in the calking, and it is unable o understand how any professional man can consider a deck properly astened when a large proportion of the fastening is placed in the seams tead of the body of the plank. That this was, and is now the condin of the Dolphin's decks, any one can see on the most casual inspecn; and further, that some of the lag screws have been backed out or rted by the calking lately attempted by the contractor. The Advisory Board alleges that the butt plates called for in the contract, and not found by this Board, are not of the "slightest importance." This Board is of the opinion that if they were of enough importance to be mentioned in the contract, that the contractor should have been required to place them.

JOINER-WORK.

This Board reiterates its opinion as to some of the details of the joiner-work in the cabin and ward rooms. It would seem, however, that the Advisory Board had authorized the departure from the specications in those respects which the Board have noted; and while the nstruction of the bureaus without backs was an economical plan for he contractor, an examination of their insides would disclose unfinished work.

This Board witnessed on one occasion a number of joiners planing and scraping down the tops and edges of the ward room dining-table to render it more presentable in appearance, overhauling the state-room doors so that they would travel without jamming, and other work of a like character, though it did not observe any attempt to make good one of the bureaus in the cabin apartments which had one of its sides cut away in the roughest manner, the veneering all or mostly hacked off in fact, apparently to make the bureau fit in its intended place in one of the state-rooms.

The "conveniences and accommodations" in the cabin and wardroom are good, though the odors noticed as coming from the wardroom water-closets, located in the close and hot wing passage, and adjacent to the ward room pantry, did not suggest itself to this Board as a particularly healthful detail. As to the berth deck, the crew of eighty men or more will find exceedingly cramped quarters there, and petty icers of the first class would miss many of the "conveniences and accommodations" they have been accustomed to on board some of our lder and larger ships.

BREAD-ROOM.

The Advisory Board says:

> The object of tinning a bread room is simply to keep out rats; the only parts not tinned are parts formed by steel bulkheads. Specifications do not require nor has any attempt been made to make the bread room water-tight * * * the gratings had been in some way misplaced.

This Board is of the opinion that bread rooms are tinned to keep out apness as well as vermin. When first examined the room was not mpletely tinned up to the deck above, but such defect was subsently remedied by the contractor. In book of Hull Specifications, e 9, it is stipulated that "the workmanship throughout is to be of most thorough character, and particular care is to be taken to ine fair lines, smooth surfaces, and perfect water-tightness"; and, as

dryness is an essential requisite of bread rooms, this Board as that, in the sense of keeping such parts of a ship free from wa reason of leakage through the sides of the vessel, or from th above, the phrase "perfect water-tightness," in that connectio not misapplied. The bread room did show indisputable signs o age of water into it from the deck above, which defect was duly

WATER-TIGHT DOORS.

The Advisory Board says that "it would be obviously inconsist fit water-tight doors to the houses where the hatches in the deck 12-inch coamings, are fitted, as customary in the naval service," a

This Board replies that the specifications read that "each deck is to be fitted with water-tight doors," and, as the engine is sep from the wardroom by a water-tight bulkhead, the point made as hatches would not seem to be well taken; and, conversely, if th tract called for water-tight doors in the deck houses, should n hatches have had some protection other than that given?

ARMORY.

The Advisory Board says that "the armory consists of a set ered racks for thirty rifles and bayonets and thirty revolvers. ordinary acceptation of the term there is no armory in the Dolphi there is no need of any."

This Board agrees to the statement that "there is no need of an a on board the Dolphin," but noting in the contractor's accou "extras" an item of $145 charged for the building of an armory ceeded to look up, examine, and report upon the same.

DYNAMO.

The Advisory Board says: "It was intended to locate the ele apparatus in the engine-room, but it was revoked on account of * * * The suggestion of covering the floor of the dynamo wit is a good one. The suggestion of a hand-rail and a protective for the switch-board is also good. * * * The Bureau of N tion suggested that the electric plant should be placed in the spa in an extension of the engine-room hatch, but on account of wei dynamo and engine and that of the extension of the house and t pense, the Board decided to locate it in its present position. * It is the custom for the electric apparatus to be under the eye navigator and not of the officer of the deck." This Board answe the dynamo, &c., might have been located on either end of the e room house without adding much more to the weight on the spa than could have been saved by omitting the needless house ov cabin companion way.

As a matter of remark, the forward part of the engine-room now presents an unsightly appearance, due to the fact that aft completion of the house the forward part was cut away, to make room for getting at the bonnet of the forward steam-chest, and t tension, had it been carried forward so as to cover the steerage and inclose the mainmast, would have afforded ample room f dynamo and engine, and have given the house a far better look t now has, and with but little additional [illegible]

The Advisory Board [illegible] hen it sugg that "it is the cus[illegible] apparatus

under the eye of the navigator, and not of the officer of the deck." So are the side lights, mast-head lights, chronometers, binnacles, compasses, and all other apparatus, instruments, and appliances, pertaining to navigation "under the eye of the navigator"; but at the very time when some of these things are in special use the navigator is fast asleep in his bunk, while the officer of the deck is always on hand.

This Board further remarks that it was an unfortunate arrangement that took away from the already limited coal space of the vessel.

BATTERY.

With regard to the battery, this Board is fully in line with the current thought of the day as to the great value of machine-gun fire; indeed, it is so impressed by the lessons taught at the battles of Sfax and Foo Chow, especially the latter, which was purely naval, that it submits the opinion that, as against an active and intelligent enemy, directing the fire of Hotchkiss cannon from under the cover of protective towers or casemates, or guns of the Gatling, Nordenfeldt, or Maxim types, mounted in ship's tops, no crew could stand for a moment at the Hotchkiss cannon it is proposed to mount on the grating platforms which were pieced onto the Dolphin's top-gallant forecastle after the near completion of that vessel; and unless the ship's 6-inch rifle is, besides its intended shields, to be protected from vertical fire, the same grave fault of mounting would seem to apply to it also.

Machine-guns, however, in their present development, notwithstanding their great range and penetrative power, must still be regarded as auxiliary to the heavy ordnance of still greater range and effectiveness forming the main batteries of ships of war, and, as the 6-inch rifle in question, the recent production of our naval Bureau of Ordnance, is the best and most effective rifled gun yet supplied our service. a gun, which in every factor and quality desirable in ordnance, is the equal, if not the superior, of any gun of like caliber yet fabricated abroad, it is no misnomer to style the main battery of a vessel, composed of one or more guns of such type and power, as the "effective battery" of the ship in contradistinction to the lighter and less effective armament the vessel may carry in the shape of machine-guns.

But, in view of the marked stress the Advisory Board lays upon the destructive range of Hotchkiss cannon, this Board begs to note—what it refrained from doing before—the extreme vulnerability of the Dolphin's engines and main machinery, which, being of the vertical type with large surfaces of exposure above the spar-deck, without any approach to adequate protection from heavy machine-gun fire, either horizontal or vertical, must be held to constitute one of the gravest defects of that vessel's design and construction, and surprising to contemplate when it is considered that the destructive power of Hotchkiss cannon was substantially known before the Dolphin's keel was laid.

In this connection it is pertinent to add that the Surprise, a dispatch-boat of about the same tonnage as the Dolphin, but reported to be much her superior in horse-power, speed, and general arrangement, recently built for the British navy, has horizontal engines, which, besides being below the water-line, have the further protection of an arched steel deck extending over them.

SHAFTING.

...d substance of the explanation about the shafting leaves ...e it was before. The contractor had contracted to supply ...ng—a thing entirely practicable and in general use. He was

answer admits the faults, but attempts to justify them becau
of others seem to be in the same unfortunate condition. I
advanced stage of the design and manufacture of such ma
excuse does not seem to carry great weight. It is believe
signs of the best engineers, and accepted generally by the p
not contain such faults.

This hurried reply to the document before us might be
more complete and exhaustive than it now stands, but in
several admissions of the Advisory Board as to the substan
ness of the report of examination, made by this Board on the
it seems needless to cover the ground any further.

GEO. E. BELK

Commodore, U. S. N., President of Board of Ex

R. D. EVANS,

Commander, U. S. N

HERMAN WIN

Constructing Enginee

and communicate after reaching Washington. As I view the matter, rule which governs individuals in these business transactions should ern the action of the Department. At all events, if there is a differ rule proper to be applied, I am not aware of it. My duty heretofore seemed to be very simple and plain. It has been to insist upon the t enforcement of contract obligations, as interpreted to me, without rd to consequences. That is the ordinary plain business method, parture from which in a public officer can have no justification, and se manner I know of no reason why the ordinary principle which ates merchants in dealing with each other, and in accordance with h generous consideration is extended ordinarily to an unfortunate ness associate, should not govern the action of the Department un- similar circumstances. The business method of dealing with the er, which would be pursued by private parties, would be, first, to me satisfied that the assignment was in good faith, and then con- the best method, from a business standpoint, of bringing about a ement of current and incomplete contracts upon a fair and just s for both parties.

I have the power, therefore, I will enter into the consideration with of the point to which the contracts have been performed, and en- or to settle upon some just and fair basis for the disposal of the ters. Of this I informed you at our meeting in New York. This se, just and right under all circumstances, is compulsory upon the ernment in the present case. The very liberal treatment which the ractor has heretofore received has left the Government without cient margin of moneys reserved to enable it to protect itself in the ent situation. The contract provided that 10 per cent should be ined from the bills as they came due, and held as security for the pletion of the work. At the present time those reservations would amounted to $210,710. They have been surrendered to the con- tor under circumstances not important to consider now, with the ption of $26,670. In addition to this small sum of $26,670 in our ds, there are unpaid bills for extras claimed on the ships amounting 26,688.95, and in dispute on the Dolphin, $29,945.08. Altogether stly in dispute) $83,304.03. As against this, four ships are in your ds, upon which over two millions has been paid, which must be con- ed to be valuable, liable to greater deterioration by neglect than all moneys unpaid and in dispute would repay. It is of the utmost sequence to the Government, as it is to yourselves, that a just settle- t of past transactions should be had and a new departure made.

suggest as a practical method of arriving at a solution of the matter eting of yourselves and your counsel with the Attorney General myself, at which some practical method of dealing with the subject be arrived at which shall be within my legal authority.

Very respectfully,

W. C. WHITNEY,
Secretary of the Navy.

The Secretary of the Navy to the Naval Advisory Board.

NAVY DEPARTMENT,
Washington, July 31, 1885.

R: I acknowledge the receipt of the communication of the Naval sory Board of July 13, covering criticisms of the report of the Ex- ing Board upon the Dolphin, with the request that the same should given equal publicity with their report. I have caused the same to

States; but such transfer shall not operate to constitute an acc under the alleged contract, or affect the consideration or adju of any question of law or fact arising upon any claim or defense hereafter in controversy between the parties, which shall be dete as if such transfer had not been made.

Second. The parties of the first part under such alleged con prosecute an action against the parties of the second part for t ance of the purchase money alleged to be due under said contr for compensation for additional work and alterations made purs the provisions of the said alleged contract.

In the event that a lien shall be determined to exist in favo United States upon said vessel, or in the event that the Gove shall be found entitled to any money judgment or reclamation able from the parties of the first part, or either of them, then, that event, the said steamship shall be first applied to the sati of said lien or judgment, and the value of said steamship, at the such transfer, for the purpose of satisfying said lien, claim, o ment, in lieu of being determined by judicial sale, shall be found court, upon proof to be advanced by the respective parties, and

The Secretary of the Navy to John Roach and others.

NAVY DEPARTMENT,
Washington, October 1, 1885.

SIRS: Having heretofore communicated to your counsel the views of the Department with reference to what may reasonably be done by the Government in the matter of the steamship Dolphin, I now, in accordance with his request, embody the same for your consideration in this formal proposition.

It is of profit to no one that she should lie, as at present, unused, at constant expense, undergoing deterioration. She represents either a ship completed according to contract, which should be accepted by the Government (which is your claim), or she represents a property upon which the Government has a lien for amounts largely in excess of any sum likely to be realized from an enforcement thereof. In this latter event the ship must answer to the Government to whatever extent she will reach to pay. Having been built for a naval vessel, she is of very doubtful market value. In my judgment she should come to the Government, leaving it to be settled by judicial determination hereafter whether your claim is correct, that she should be accepted under the contract, or the claim of the Government is correct, that she must answer for the lien created by the moneys advanced in the course of her construction. Neither of us should object to a speedy and fair settlement of the questions at issue by judicial determination without unnecessary hardships to either. The important things, so far as I am able to see, to be covered by stipulations, are that the transfer of possession to the Government shall not work an acceptance under the contract, unless it is judicially determined that you are entitled to compel such acceptance. By instituting a suit for the balance of the purchase-money unpaid, that question can be speedily determined. In that event a judgment for the balance will settle the controversy; but in the event that the law and the facts should be found otherwise, the transfer of the ship to the Government shall then be considered to have been in recognition of the right of the Government to a foreclosure of its lien for moneys advanced in the course struction; and in lieu of the hardships which would result from a judi sale of a vessel not built for mercantile purposes (a harsh manner of liquidating the Government's claim), I can see no reason why the following should not be resorted to as a reasonable and just disposition of the question as to the value of the vessel for the purpose of satisfying the lien. Her value as a naval vessel shall be assumed to be the contract price. If she is found in all respects up to the requirements legally binding upon you in her construction, she is taken by the Government at that price, otherwise she is taken at such less sum as shall be found necessary to be spent upon her to make her up in all respects to such standard. In other words, the Government takes her, and will expedite a determination by the court whether she is taken and accepted as for a valid and completed contract, or in satisfaction of the lien, and the method of determining her value for the purpose of the lien is agreed upon reasonably and fairly. In all other respects the rights of the parties to be unaffected.

Very respectfully,

W. C. WHITNEY,
Secretary of the Navy.

Messrs. JOHN ROACH, LEVI KERR, and A. R. WHITNEY.

No. 16.

REPORT

OF THE

[AVAL ADVISORY F

ON THE

MILD STEEL

USED IN THE CONSTRUCTION OF THE H
AND MACHINERY

OF THE

DOLPHIN, ATLANTA, BOSTON, A

FOUR STEEL VESSELS CONSTRUCTED UNDER THE ACTS
OF AUGUST 5, 1882, AND MARCH 3, 1883.

PREPARED BY

ASSISTANT NAVAL CONSTRUCTOR R. GATEWOOD, U. S. N.,

FROM THE RECORDS OF THE BOARD.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1885.

LETTER OF TRANSMITTAL.

NAVAL ADVISORY BOARD,
NAVY DEPARTMENT,
Washington City, July 27, 1885.

SIR: The Board respectfully forwards herewith its report on mild steel supplied for the construction of the Chicago, Boston, Atlanta, and Dolphin.

Tl report has been prepared in accordance with the synopsis pre- sen i with our letter to the Department of November 17, 1884, by As- ant Naval Constructor R. Gatewood, U. S. Navy, from the data con- d in records of the Board.

Very respectfully,

E. SIMPSON,
Rear-Admiral U. S. N.,
President of the Board.

Hon. W. C. WHITNEY,
Secretary of the Navy.

INTRODUCTION.

THE INCREASING USE OF MILD STEEL IN THE UNITED STATES PRIOR TO ITS ADOPTION AS THE MATERIAL OF CONSTRUCTION FOR THE FOUR VESSELS APPROPRIATED FOR MARCH 3, 1883.

Mild Steel for Locomotive Boilers.—The advantages to be gained by the use for the fire-boxes of locomotives of a material sufficiently homogeneous to stand the heat of a coal fire with steam blast without the development of blisters, with consequent uncertain and generally short life, as with the iron plates then used, led the authorities of the Pennsylvania Railroad to construct in July, 1861, in its shops at Altoona, Pa., a fire-box of English (crucible) steel. Owing probably to improper manipulation, but, possibly, also to bad quality as well as too high carburization of the steel used, the first attempt was not successful, one of the plates, accidentally let fall after flanging, breaking in the most brittle fashion like glass. In 1865 a second fire-box was made, this time of American crucible steel, supplied by Hussey, Wells & Co. (now Hussey, Howe & Co.), of Pittsburgh, Pa., and was so successful in use that in the next year eighteen steel fire-boxes were constructed, seven of English steel and eleven of the above American steel; while, in June of the same year, 1866, an entire boiler was built of American metal. In 1867 eighteen fire-boxes were made of the same material.

From 1868 dates the decided use of steel for boiler construction by the Pennsylvania Railroad: in that year twenty-seven boilers of steel throughout, besides fifteen steel fire-boxes for iron boilers, being constructed. In 1869 thirty-seven steel boilers were constructed, and thereafter the number of iron boilers constructed diminished rapidly, the last one—a stationary boiler—being built in July, 1873. After 1868 all iron fire-boxes were replaced by steel as they came in for repairs, while improvement in quality of material and in workmanship is evident in the long life of these fire-boxes, from ten to even fifteen years, though not in such continued and severe service as is now common.*

All this success had been obtained with crucible steel of high cost, so that other railroads were naturally slow to undertake the change from iron to steel, although experimental boilers of steel from this time on commenced to appear on various roads. The Bessemer process was introduced into the United States in 1865, but soft steel so manufactured has not been used in locomotive-boiler construction to any extent. The open-hearth process, introduced in 1868, soon became the chief, and is

* The average life of a steel boiler on this road is now reckoned at thirteen years, while that of a fire-box is only six years, the longer fire-boxes, 113 by 36 inches, having the shortest life.

now almost the only, source of supply, steel of this manufacture practically entirely replacing crucible steel after 1875.

The use of steel for boilers on the Pennsylvania Railroad was not without incidental failure both under construction and in service, though the care of steel boilers in use seems to have been the subject of considerable attention and helps to account for their special immunity from accident. Up to 187 the steel was generally taken on the maker's guaranty, but from that year the testing of boiler steel became part of the regular routine work, and at present every sheet of boiler, fire-box, or tank steel used in the shops of the railroad, or in outside construction for them, is tested in the testing department of the road at Altoona, Pa. As the pioneer road in the use of steel in boiler construction, their specifications and method of test have been closely imitated by other prominent roads, and most of the high-grade mild steel made subject to test at the time of the adoption of this material for the construction of naval vessels was expected to fill these or similar specifications. Certainly not less than 7,500 tons of steel had been used in locomotive-boiler construction, of which probably 6,000 tons had been made to specifications and subject to test The specifications and method of test in use are accordingly of interest as being those with which the steel manufacturers expressed familiarity and as being also probably the most rigid up to that time exacted.

SPECIFICATIONS FOR BOILER AND FIRE-BOX STEEL FOR THE PENNSYLVANIA RAILROAD.

(1) A careful examination will be made of every sheet, and none will be accepted that show mechanical defects.

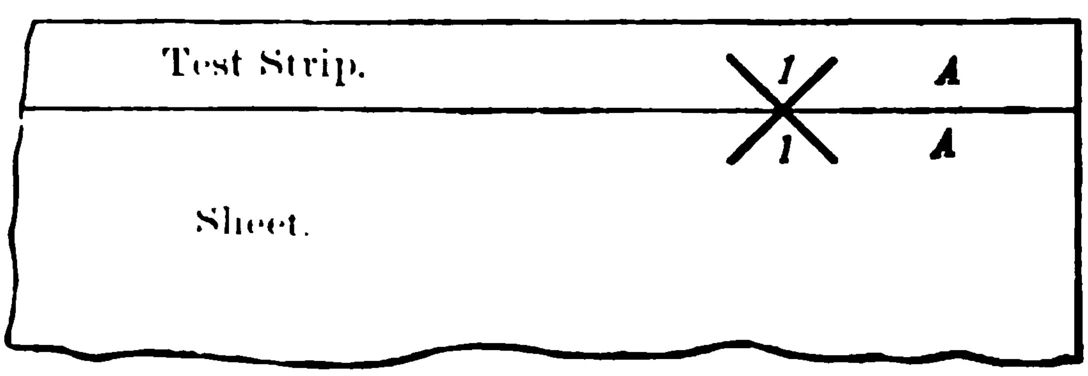
(2) A test strip taken from each sheet lengthwise of the sheet, and without annealing, should have a tensile strength of 55,000 pounds per square inch, and an elongation of 30 per cent. in a section originally 2 inches long.

(3) Sheets will not be accepted if the tensile strength is less than 50,000 pounds or greater than 65,000 pounds per square inch, or if the elongation falls below 25 per cent.

(4) Should any sheets develop defects in working, they will be rejected.

(5) Manufacturers must send one test strip for each sheet (this strip must accompany the sheet in every case), both sheet and strip being properly stamped with the marks designated by this company, and also lettered with white lead to facilitate matching.

The method of test is as follows: Each steel manufacturer is furnished with a so-called "shear-mark," which, together with a letter indicating the position of the sheet in the boiler, must be stamped upon each sheet. In removing the test piece, the plate is sheared through the "shear mark" thus, so that, when received at the works, the test



strips may be matched to the corresponding sheets. The piece is then shaped for test as in Fig. 1, in which it will be noticed that the 2-inch measured length for elongation includes ¼-inch fillets at each end, and

that the proportion of the test piece is subject to important variation between the extremes of thickness of ¼ and ½ inch.

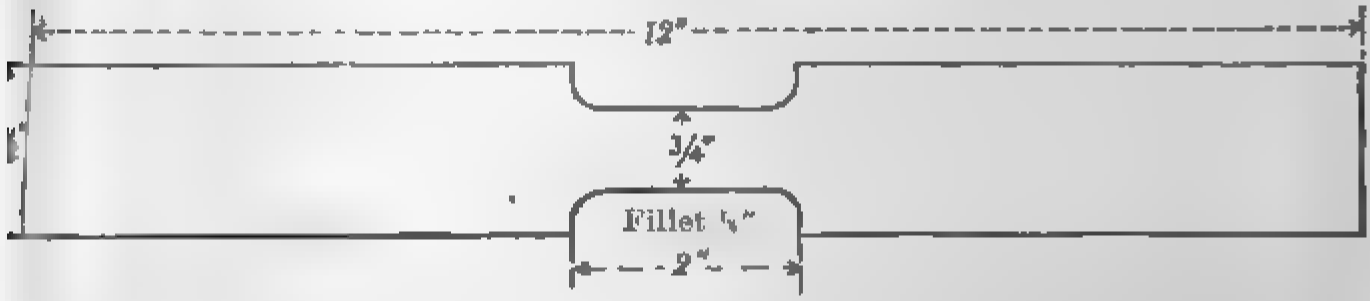


Fig 1.

The pieces are broken by continuous pull in a 100,000 pound Riehlé hydraulic machine similar in all respects to that shown in Fig. 4, p. 403.

Similar specifications and methods of tests, with occasional slight individual modifications, are in use in most of our railroads, and in the large locomotive works for steel not specified for by the purchaser. A commendable tendency appears, however, towards the use of longer test pieces, as in the Chicago, Burlington, and Quincy Railroad, whose specifications are as follows:

A test strip lengthwise of the sheet, and without annealing, should have a tensile strength of 55,000 pounds per square inch and an elongation of 28 per cent. in a section originally 4 inches long. Sheets showing less than 50,000 pounds, or more than 60,000 pounds, or an elongation under 25 per cent., will be rejected. Samples to stand bending or hammering down, either hot or cold, after being chilled from a cherry red heat, without a flaw or crack.

Mild Steel for Stationary Boilers.—Information is not readily accessible as to the history or extent of the use of steel for stationary boilers, though thousands of tons have been so used, especially of late years. As to the degree of success obtained, Prof. R. H. Thurston mentions* that the manufacturing house of Kendall & Roberts, Cambridgeport, Mass., report that of several thousand boilers built of steel, they have never had one to fail or give any trouble. It is very likely that the supply of steel for this purpose is mainly under guaranty of the manufacturers.

Mild Steel for Naval Boilers.—The conditions under which this material was adopted and has been used by the Bureau of Steam Engineering, Navy Department, for the construction of naval boilers appear to have been as follows:

As early as April, 1875, samples of mild steel submitted by the well-known Otis Iron and Steel Company were tested at the Washington navy yard, the tests being reported "very severe and in every way satisfactory." It would appear that up to this time requirements for tensile strength had not been exacted for boiler iron, but in 1877 efforts were made, by correspondence and public advertisement, to obtain for new boilers of the Nipsic a higher grade of iron than had hitherto been used, the specifications demanding "the very best quality of American flange iron, to stand a test of not less than 55,000 pounds to the square inch"—presumably in the grooved test piece then in general use—but without success. It was stated, however, that all the conditions could be met by using mild steel, and the Otis Iron and Steel Company again submitted samples of this material for test at the Washington navy-yard, the report on which (January, 1878) contains the opinion that "the advantages of this material for purposes under cognizance of the Bureau of Steam Engineering would be facility of working, security

*Trans. Am. Inst. Mech. Engrs., Vol. IV., 1883, p. 436.

against blisters in crown sheets of boilers, great tensile strength an sequent reduction in weight of boilers, and a longer life of boile account of the corrosive action being less upon this material than ordinary iron." Shortly after (March, 1878), at the request (authorities of the Fish Commission, mild steel was ordered a material for new boilers for the Fish Commission steamer Lookout by agreement at the Washington navy-yard.

Meanwhile efforts were continued to obtain the higher grade o demanded for the Nipsic's boilers, and after the failure of nun brands under test, samples of the well-known "Sligo" brand pass tests. But the plates of this brand as supplied failed to meet the and in view of the perfect working of the mild steel for the Loo boilers under construction, the agent was allowed to fill the co with similar material.

Once in use, the material gave such satisfaction that no oth since been used. But before finally adopting it for general use, sa of various manufactures were sent to all the navy-yards for t comparison with one another and with representative brands o the reports being invariably favorable to the new material aft consideration of all qualities, including the higher cost of the st

Table I. gives the chief items of information for the steel us this Bureau up to January 1, 1884, from which it is seen that mil for 111 boilers, requiring 3,411,780 pounds—1,523 gross tons—ha supplied.

TABLE I.—*Mild steel supplied to the order of the Bureau of Steam Engineering struction of main steam boilers (excluding auxiliary and cutter boilers) up to 1, 1884.*

Date of order.	Vessel.	Number of boilers.	Weight of steel delivered.	Navy-yard.
1878.			*Pounds.*	
Nov. 1	Nipsic	*6	129,981	Washington.
1879.				
July 3	Mohican	†8	156,939	Mare Island.
July 11	Iroquois	*6	154,638	Do.
Oct. 17	Despatch	*2	75,704	Washington.
1880.				
May 6	Ranger	*4	69,308	Mare Island.
May 10	Tallapoosa	*2	173,241	Washington.
June 30	Alert	*4	82,319	Mare Island.
June 30	Enterprise	*6	150,560	Washington.
June 30	Essex	‡6	164,607	New York.
June 30	Tuscarora	§6	77,452	Mare Island.
Sept. 16	Snowdrop	*1	35,658	Norfolk.
Oct. 26	Fortune	†2	65,423	Washington.
Oct. 26	Pinta	*2	84,335	Do.
Dec. 18	Ticonderoga	§4	181,429	Do.
1881.				
May 9	Monongahela	¶4	189,511	Mare Island.
May 11	Ossipee	*4	181,324	Washington.
May 11	Rescue	*1	40,852	Do.
June 28	Marion	*8	176,761	Do.
Aug. 1	Pilgrim	*1	45,569	League Island.
Oct. 31	New York	†6	299,141	Washington.
1882.				
June 28	Adams	‡6	130,035	Mare Island.
June 28	Alliance	*6	129,252	Norfolk.
June 28	Benicia	‡4	203,634	Mare Island.
June 28	Powhatan	‡4	228,641	New York.
June 28	Vandalia	†8	175,468	Norfolk.
	Total	111	3,411,780	

*Completed and in service.
†Completed, but not in service.
‡Partially completed.
§ Not yet commenced.
¶ Partially completed for Monocacy

This steel was first required to have a tensile strength of about 60,000 pounds to the square inch,* and to stand the severest flanging tests. In June, 1882, the requirements were "to stand the severest flanging tests, and have a tensile strength between 57,000 and 60,000 pounds to the square inch." In December, 1882, practically the same specifications were issued as subsequently adopted by this Board, viz: "To be of uniform thickness and smooth surface, to stand the severest flanging tests, and have a tensile strength between 57,000 and 60,000 pounds to the square inch, with a ductility in 8 inches of not less than 25 percentum."

Mild Steel for Bridges.—In the construction of the great Saint Louis bridge across the Mississippi River, in 1869, nearly 3,000 tons of steel were used, all crucible, and much of that description of crucible steel in which chromium, instead of carbon, is the chief hardening element. This steel is remarkable for its toughness, even in the harder qualities, but its cost is high. Its use at the time was considered a bold piece of engineering, and the experiment was not repeated.

The progressive use of mild steel for bridge building dates from 1879, when Bessemer plates and shapes were adopted for the roadway girders and the approaches of the East River suspension bridge. Thence, suc- [illegible]ively, railroad bridges in increasing number have been constructed of s[illegible]el, as given in the accompanying Table II. Of course, the use of [illegible] as wire is not here referred to, but only as worked in ordinary [illegible]ural shapes. Open-hearth steel has been the preferred material, [illegible]ally for tension members, a slightly harder grade being used than [illegible]p construction, the general specifications being 70,000 to 75,000 [illegible]nsile strength, with 20 per cent. elongation of a ¾-inch round in [illegible]s. For compression members and pins, 80,000-pound steel, with [illegible]ondingly less elongation, is required. As illustrating the quality of material in use, extracts are given in the appendix (p. 577 *et seq.*) from the specifications for a railroad bridge recently constructed. Bridge specifications are not, however, generally so confining as to each individual quality of the material.

TABLE II.—*Steel Bridges in the United States.*

Date.	Bridges.	Steel manufacturer.	Weight of steel.	Description of steel.
			Tons.	
1869.	Saint Louis Bridge	Butcher	2,900	Carbon and chrome.
1879–'83.	East River Bridge	Cambria Iron Company	6,300	Bessemer.
1880.	Plattsmouth Bridge		497	Siemens-Martin.
1881–'82.	Bismarck Bridge	Spang Steel and Iron Company		
1883.	Blair Bridge	Cambria Iron Company	432	Open-hearth.
1883.	Willamette Bridge	Spang Steel and Iron Company	600	Do.
1883.	Niagara (new R. R.) Bridge	do	250	Do.
1883.	Point Pleasant Bridge	do Cambria Iron Company	 100	Do.
1884.	Henderson Bridge	do	900	Do.
1884	Port Deposit Bridge	Carnegie Brothers	5–6,000	Bessemer.

Mild Steel for Ship-Building.—The use of steel for ship-building was by no means so well advanced as in the other leading branches of iron construction. Only one establishment, the Pusey & Jones Company, of Wilmington, Del., appears to have given the subject practical attention, and they had constructed but five little river-steamers and six lighters with steel plating, most of which was imported. Neverthe-

*Presumably on a test piece 5 or 6 inches long, as these lengths were used by Boards reporting on the material.

less, they were in a position to express before the Congressional committee a decided opinion as to the reliability of steel hulls in collision and grounding, Mr. William Gibbons, president of the company, describing the behavior of one of these little vessels thus:*

"My company have built a number of steel vessels, several of which have been intended for the navigation of the river Magdalena, in the United States of Colombia. Parts of that river are rapid and full of rocks and snags, and the vessels were built of these sheets of steel, much thinner than we have ever used for iron vessels, and they have been thumped and banged against rocks and stones until one of those boats is all dinged, just as if you had taken a leather bag and kicked it about, yet there has been no sort of fracture."

It is seen from Table III., believed to be a complete account of steel ship-building in the United States up to the date of writing, that the four vessels for the Navy were the first to be commenced of steel throughout, although smaller vessels have been completed before them. Other vessels are under construction, and the list will be materially increased by the end of 1885.

* "Reconstruction of the Navy," H. R. Report No. 653, 47th Congress, 1st session, p. 122.

Name of vessel.	Wholly or partially of steel.	Dimensions. Length.		Beam.		Depth.		Displacement. Light.	Load.	Type.	Owner.	Commenced.	Finished.	Description of steel used.	Tensile strength.	Ductility in 8 inches.
		Ft.	Ins.	Ft.	Ins.	Ft.	Ins.	Tons.	Tons.						Lbs. per sq. in.	Per ct.
Tolima*	Plating only.	100	0	24	0	4	0	100	....	Side-wheel steamer	F. J. Cisneros, Barranquilla, U. S. Colombia.	1879	1879	Unknown. Purchased through agents.	55,000 to 60,000	
Santa Marta*	do	60	0	15	0	3	0	26	....	Stern paddle-wheel steamer.	....	1879	1879			
Eonce de Noviembre.*	do	120	0	24	0	4	0	120	....	do	Government of U. S. of Colombia	1879	1879			
(*)	do	40	0	10	0	3	0	13	....	do	....	1879	1880			
Emilia Durán.*	do	120	0	24	0	3	10	100	....	do	F. J. Cisneros	1881	1882			
2*	do	55	0	25	0	3	6	40	....	Lighters	do	1881	1882			
4*	do	50	0	18	0	3	0	25	....	do	do	1881	1882			
(*)	do	36	0	7	6	3	6	7	....	Propeller	Junta de la Canalizacion del Rio Magdalena.	1883	1883			
Olympian†	do	260	0	40	0	14	3	1,246	1,400	Side-wheel bay steamer.	Oregon Railway & Navigation Co.	1883	1883	Domestic open-hearth.	65,000	16
Apure*	do	150	0	30	0	6	0	230	....	Stern paddle-wheel steamer.	General Steamship Co., Trinidad, W. I.	1883	1884	Purchased through agents.	55,000 to 60,000	
Libertad*	do	75	0	17	0	4	0	40	....	do	do	1883	1884			
Dolphin‡	Wholly	240	0	32	0	19	9	....	1,500	Dispatch boat	U. S. Navy	1883	1885	Domestic open-hearth.	Over 60,000	Over 23
Atlanta‡	do	270	0	42	0	26	3	....	3,000	Protected cruiser	do	1883	....	do	do	Do.
Boston‡	do	270	0	42	0	26	3	....	3,000	do	do	1883	....	do	do	Do.
Chicago‡	do	315	0	48	2	34	10	....	4,500	do	do	1883	....	do	do	Do.
Nourmahal†	do	221	0	30	0	20	0	850	1,150	Propeller yacht	William Astor, New York	1883	1884	do	65,000	16
Electra†	do	162	0	23	0	14	3	350	450	do	E. T. Gerry, New York	1884	1884	do	65,000	16
Tioga§	do	301	6	38	0	25	6	1,000	3,530	Lake steamer	Union Steamboat Co., Buffalo, N. Y.	1884	1885	Chiefly Bessemer	61,880 to 68,160	26 to 30.75

* Built by the Pusey & Jones Shipbuilding Co.
† Built by the Harlan & Hollingsworth Co.
‡ Built by Messrs. John Roach & Son.
§ Built by the Union Dry Dock Co.

REPORT ON MILD STEEL.

Part I.

CONSIDERATIONS LEADING TO THE USE OF MILD STEEL IN THE CONSTRUCTION OF THE VESSELS.

We have seen that a certain amount of progress had been made and experience obtained in the use of mild steel as a structural material in the United States, when such use on a large scale for the construction of the hulls of vessels of war was brought into prominent notice by the report of the Advisory Board, convened by the Secretary of the Navy June 29, 1881, to suggest the number and classes of vessels needed for the United States Navy, and commonly known as the first Advisory Board. This Board consisted of fifteen representative officers of the line and *matériel* corps of the Navy, and their report to the Department, November 7, 1881, developed the fact that the use of mild steel for construction of hulls had been carefully considered, as fully discussed as the means of information at the time allowed, and was the chief source of a difference of opinion so strong as to call for a divided report. The large majority of the Board reported favorably to the use of mild steel as a material for the hulls of the larger vessels at that time proposed, as follows:

> The most difficult question brought before the Board for its decision has been that of the proper material of construction for the hulls of the vessels of the larger classes. It was at first decided that, since iron shipbuilding is now well developed in the United States, since the excellence and economy of this material for the hulls of vessels has long been indisputably established, and since iron vessels could be built with an absolute certainty that they would fully meet all requirements of efficiency, the Board should recommend iron as the material of construction.
>
> Upon further investigation, however, the Board is of the opinion that, notwithstanding the greater cost of steel as a ship-building material, the lack of experience in the manufacture of steel frames in this country, and the experimental stage that steel shipbuilding is still passing through in Europe, it should be recommended as the material of construction for the hulls of the 15, 14, and 13 knot vessels, for the following reasons:
>
> 1st. The great saving realized in weight of hull, which, by making possible the acquirement of equal advantages on reduced dimensions, compensates in a great measure, if not entirely, for the difference in cost between steel and iron.
>
> 2d. The increased strength of hull and increased immunity from damage in grounding or in light collisions.
>
> 3d. The rapidly increasing success that attends the construction of steel hulls in Europe.
>
> 4th. The certainty that steel is in the very near future to almost entirely supplant iron in the construction of vessels.
>
> 5th. The impetus that such a step, taken by the Government, would give to the general development of steel manufacture in this country.
>
> 6th. The necessity that, when the ships recommended are completed, they shall in all respects be equal to, if not better than, any of their class in foreign navies

Finally, that for the reputation and the material advantage of the United States it is of prime necessity that in this country, where every other industry is developing with gigantic strides, a bold and decided step should be taken to win back from Europe our former prestige as the best ship-builders of the world.

It is therefore the opinion of the Board that the 15, 14, and 13 knot classes of vessels should be built throughout of steel.

The considerations governing this report are plainly the extended and increasing use of steel for ship-building in Europe, and the belief, though upon no particular or extended evidence, that at least equally good material could be furnished of the necessary shapes and quality by American manufacturers without excessive cost.

While other points of uncertainty as to the new material were advanced in the minority report, it became evident, in subsequent discussion, that the adverse opinion of the three officers of the Construction Corps of the Navy, on the Board, as to the use of steel was based mainly upon the latter consideration, viz, uncertainty as to the ability of the American manufacturers to produce the desired material without excessive cost.*

The difference of opinion which caused a divided report of this Advisory Board was considered lamentable at the time, though possibly in the end it was not to be regretted, because, the matter coming in this shape before the Forty-seventh Congress, the Naval Committee of the House instituted an exhaustive examination as to the relative merits and probable difference of cost of puddled iron and ingot mild steel as constructive materials for ships of war. Prominent ship-builders and iron and steel manufacturers and workers gave evidence before the committee unanimously in favor of the use of mild steel, while actual experiments were made at the Washington navy-yard and conclusive testimony adduced as to the magnificent behavior of the mild steel exclusively used there for the boilers of naval vessels.†

Then followed the conference, above referred to, between the Senate and House Committees and the Advisory Board, at which the dissentint members, with but a single exception, expressed their conviction, inefavor of the use of mild steel.

Accordingly the report of the House Committee on Naval Affairs accompanying H. R. Bill 5001, March 8, 1882, contains the following:

MATERIAL.

Your committee have been greatly aided by the report of both majority and minority, and we have felt entirely safe in following their views on all matters in which they agreed.

The only questions they disagreed upon, which in any way affect the report of this committee, are two in number, and are as follows: first, whether steel or iron shall be used in the construction of vessels recommended to be built; second, whether the second size vessel recommended shall be built with open or spar decks.

The first of these questions the committee felt called upon to decide for themselves, and, after carefully taking the opinions of the most extensive and experienced manufacturers of steel and iron in this country whom we could reach, we have unanimously decided that steel should be used instead of iron, and we are of the opinion that if the members of the Advisory Board could have had before them the same evidence as the committee had, and could have been as fully informed as to the progress, extent, and present condition of the manufacture of steel in this country as the committee have been, they would have all united in recommending steel as the only proper material for the construction of vessels of war. We understand that the reason why any advocated the use of iron was because of a doubt whether steel of the requi

* See "Reconstruction of the Navy," previously referred to, under heading, "Notes of a conference held in the office of the Secretary of the Navy between members of the Senate and House Committees on Naval Affairs, members of the late Advisory Board, and other officers of the Navy," p. 190 *et seq.*

† "Reconstruction of the Navy," H. R. Report No. 653, Forty-seventh Congress.

ite quality could be produced in this country in sufficient quantity and at reasonable cost. But on these points there would seem to be no ground for reasonable apprehension, and we recommend steel without hesitation or doubt. The evidence taken by the committee is herewith reported, and we commend it to the consideration of Congress.

The committee were surprised and gratified to learn that the United States is today the second country in the world, if not indeed the first, in the extent of the manufacture of steel, and that steel of American manufacture is better than that made in Europe. Specimens of open-hearth steel (which is the best for ship-building purposes, as the evidence clearly shows) from several of the largest manufactories in the country were presented to the committee, and may now be seen in the committee-room. This class of steel is uniform in character, and has a tensile strength of from 55,000 to 63,000 pounds to the square inch, and a ductility of 30 per cent. It is capable of being folded cold under heavy hammers without crack or fracture. A portion of the committee visited the navy-yard at Washington for the purpose of witnessing experiments with this class of steel. Specimens taken from the scrap-heap of two different manufactories, that of Park Brothers & Co., of Pittsburgh, and the Otis Steel Company, of Cleveland, were submitted to the severe test named, and both exhibited equal ductility and strength. Another specimen, from the works of the Norway Iron Company at Boston, of equally good quality, was placed in the hands of the committee, and also specimens from Shoenberger & Co., of Pittsburgh.

Your committee have also before them numerous specimens of iron which has heretofore been used in the construction of vessels. The difference between steel as at present manufactured in this country, adapted for ship-building purposes, and iron, commonly used, is so great and so much in favor of steel that we would commit a great wrong should we leave the question open. As to the kind of steel which this country can produce, including Bessemer steel, we simply have to say that the production is unlimited. With their present facilities, besides supplying the demand for other purposes, it is believed from the evidence before the committee that the manufacturers of open-hearth steel in this country would be able to furnish 100,000 or 200,000 tons per year, superior to any made elsewhere in the world, should the Government demand so great an amount. It appears in the evidence that the Government has abandoned the use of iron for the manufacture of boilers, and for the last four years has made use exclusively of open-hearth steel for that purpose.

We call attention to the statement of Mr. George Wilson, superintendent of machinery at the Washington navy-yard, found on page 129 of the accompanying evidence. Mr. Wilson says:

"If you get a good piece of iron, and it does not break, there is no difference in the cost of working, but in the difficult flanges there is great liability of spoiling the iron. You will spoil about 10 per cent of the iron flanges. You may have men working ten days on a sheet of iron, and then have it spoiled. But we have never spoiled but one sheet of steel. In the many thousands that we have used in the last four years we have spoiled but one; and even that we could have used."

The committee are satisfied that in all respects steel is the best material for ship construction, and we therefore unhesitatingly recommend it.

While the danger of attempting to obtain too great economy of weight by using steel of too high tensile strength and consequent low working quality was made perfectly plain during the investigation, on the other hand it appears to have been thoroughly realized that the strength of the very softest grades was too low to obtain sufficient economy over iron to warrant the more expensive construction, and, in fixing the lower limits of tensile strength and ductility subsequently adopted, Congress was doubtless guided by the evidence before it as to the specifications in use in foreign navies and insurance societies, under which thousands of tons of shipping had been constructed.

The act of August 5, 1882, authorizing the construction of certain new vessels contains the following provision as to material: "Such vessels * * * to be constructed of steel, of domestic manufacture, having as far as may be a tensile strength of not less than 60,000 pounds to the square inch, and a ductility in 8 inches of not less than 25 per centum;" in which it will be observed that the lower limit of tensile strength, 60,000 pounds, or 26.70 tons, per square inch, lies between the 26 tons of the British Admiralty and the 27 tons of Lloyd's Insurance Registry, while the ductility required is one-quarter higher, thus showing the confidence acquired during its investigation, that our steel manufacturers

could produce a higher grade of material than is demanded for ship-building purposes in Europe, a conclusion fully borne out by the results embodied in this report.

The provision as to quality of material contained in the act of August 5, 1882, was continued in the act making appropriations for the naval service, approved March 3, 1883, under which the vessels now building were commenced.

Shortly after the passage of this act, the Board addressed the following circular letter, under date of March 21, 1883, to prominent steel and iron manufacturers relative to their capacity to furnish such material as would probably be required. No detailed information could be at that time furnished, since the designs of the vessels were not in a sufficiently forward state.

NAVAL ADVISORY BOARD, NAVY DEPARTMENT,
Washington City, March 21, 1883.

Messrs. ——— ———:

The Naval Advisory Board, wishing to obtain positive information with regard to the capability of American manufacturers for providing the material necessary for the construction of the unarmored cruisers to be built for the Navy, will be obliged if you will kindly answer the following questions at your earliest convenience.

Can you manufacture, with your present existing plant and appliances, the following specified shapes? The material to be of steel of domestic manufacture, having as near as may be a tensile strength of not less than 60,000 pounds to the square inch, and a ductility in 8 inches of not less than 25 per centum, viz:

ANGLES.

Size.	Weight per foot-length.	Size.	Weight per foot-length.
	Pounds.		*Pounds.*
2 by 2 inches	3½	5 by 3 inches	10
2¼ by 2¼ inches	4½	4 by 3 inches	10
2½ by 2½ inches	5	5 by 3½ inches	11
3 by 3 inches	7	4 by 3½ inches	12
3 by 3½ inches	8½	6 by 3½ inches	14

T BARS.

4½ by 3 inches	8½		

BULB BEAMS.

6 by 4½ inches	18	9 by 5½ inches	31
8 by 5 inches	23	10 by 5½ inches	32
9 by 5 inches	27		

Z BARS.

PLATES.

[From 8 to 30 pounds per square foot.]

Weight.	Size.
30-pound plates	5 by 16 feet.
22-pound plates	4½ by 16 feet.

Very respectfully,

Co r *I.*

The replies which follow show both willingness and ability to undertake the work, with the exception, perhaps, of the larger deck-beams:

[Oliver Bros. & Phillips.]

PITTSBURGH, *April* 17, 1883.

DEAR SIR: We are prepared to roll steel plates and bars, and in that view request that you kindly mail us specifications of the sizes and quality of the above material required by the Government in the new vessels ordered by Congress to be constructed.

Yours truly,

OLIVER BROS. & PHILLIPS.

Hon. W. E. CHANDLER,
Secretary of the Navy, Washington, D. C.

[The Nashua Iron and Steel Company.]

NASHUA, N. H., *March* 23, 1883.

DEAR SIR: Yours of 21st instant at hand and in reply would say that with our present existing plant and appliances we can only manufacture the steel rectangular plates referred to, viz: 8 to 30 pounds per square foot. The 30 pound plates to be 5 by 16 feet; the 22 pound plates to be 4 by 16 feet.

Respectfully, your obedient servant,

J. D. SWAIN, *Superintendent.*

P. S.—We send you by mail to-day a small book giving list of goods we manufact-

R. W. SHUFELDT,
Commodore, U. S. Navy, President Naval Advisory Board.

[Park, Brother & Co.]

PITTSBURGH, PA., *March* 24, 1883.

DEAR SIR: We are in receipt of your favor of 21st instant and in reply would say we are not prepared to make angles, T bars, or Z bars.

We are prepared to make bulb beams which we presume are not rolled to shape, of the sizes, dimensions, and quality you require.

would be pleased at any time to make you an estimate of price.

Yours truly,

PARK, BROTHER & Co.

R. W. SHUFELDT, Esq.,
Commodore, U. S. Navy,
President Naval Advisory Board, Washington, D. C.

[Carnegie Bros. & Co., Limited.]

PITTSBURGH, *March* 24, 1883.

DEAR SIR: We are in receipt of your circular letter of 21st March. We are now d to roll nearly all the sizes of angles, tees, beams, &c., you specify, of steel. we cannot at present make we will have rolls for by the time the material is l.

We cannot, however, make plates exceeding 36 inches in width. We note your specification calls for 54 and 60 inch plates.

The steel we propose furnishing will meet all the specified requirements.

We shall be glad to make tender whenever called upon so to do.

Yours respectfully,

CARNEGIE BROS. & CO., LIMITED,
H. P. POPE.

R. W. SHUFELDT,
Commodore, U. S. Navy,
President Naval Advisory Board, Washington, D. C.

[Singer, Nimick & Co., Limited.]

PITTSBURGH, PA., *March* 23, 1883.

R SIR: We have your favor of the 21st instant to hand; contents noted.

h to say in reply, that we are not prepared to make the shaped material your before us describes.

y yours,

SINGER, NIMICK & CO., LIMITED,
GEORGE SINGER,
Secretary & Treasurer.

DT,
U. S. Navy,
dent Naval Advisory Board, Washington, D. C.

[A. R. Whitney & Co.]

NEW YORK, *March* 26, 1883.

DEAR SIR: We are not prepared to make the angles, Tees, and Z bars of steel, but can supply the plates. We can, however, supply the shapes of steel from Messrs. Carnegie Bros. & Co., Pittsburgh, to whom you have already applied, and who will quote you direct.

Yours truly,

A. R. WHITNEY & CO.

Commodore R. W. SHUFELDT,
Washington, D. C.

[A. R. Whitney & Co.]

NEW YORK, *April* 12, 1883.

GENTLEMEN: Since writing you we have arranged to make the steel shapes, as inquired for in your favor of 21st instant.

Yours truly,

A. R. WHITNEY & CO.

NAVAL ADVISORY BOARD,
Washington, D. C.

[The Midvale Steel Company.]

PHILADELPHIA, *March* 24, 1883.

DEAR SIR: Your esteemed favor of the 21st instant, regarding steel shapes and plates for ship-building purposes, came duly to hand and we note contents. The matter of rolling shapes from steel received much attention from this company, and in rolling such material for the superstructure and approaches of the Brooklyn Bridge, we made, we believe, the first lot of any amount of steel shapes ever manufactured in this country. Inclosed please find a blue print of the shapes rolled by us for the Brooklyn Bridge, for which we now have the required rolls. The shapes which you require for ship-building purposes, excepting the angles, are quite different from any we have yet manufactured, but we do not think there will be any serious difficulty in their production.

We are now, however, giving the matter our careful consideration; in the course of a few days can speak more clearly upon the subject, when we will again communicate with you. As regards the steel of which such shapes will be made, we think we will have no difficulty whatever in producing, uniformly, a metal showing the physical properties required. Our mill is not now equipped for rolling plates, having been altered to a bar-mill for the purpose of rolling the shape work above referred to. We would always be in a position to furnish hammered blooms of any specified quality of steel for rolling into plates. In manufacturing steel in the open-hearth furnace, it has always been our endeavor to produce certain definite grades, with the greatest possible regularity; and we would have no hesitation in undertaking to produce a thoroughly satisfactory article for ship-building purposes. We will write you more definitely in the near future about the shapes you may require. There would, of course, be no difficulty in rolling the angles.

Very respectfully,

R. W. DAVENPORT,
Superintendent.

R. W. SHUFELDT,
President of Naval Advisory Board, Washington, D. C.

[The Midvale Steel Company.]

PHILADELPHIA, *April* 3, 1883.

DEAR SIR: On looking more carefully into the matter of rolling the deck, or bulb beams, concerning which you inquired in your favor of March 21st, we find that, owing to the great width of flange required in the 8, 9, and 10 inch beams, it will require a very great pressure to bring the flanges up perfectly from a square steel billet or bloom, and we fear that, with the largest mill we have at present (which is a 23-inch mill, about the same size usually employed in rolling rails), we will not be able to do this work. As, however, we are anxious to turn our production in the direction of special steel shapes, we will keep the subject in mind, and will be much obliged if you could let us have a drawing showing the exact sections and shapes of steel bars which will probably be required in ship-building. We could, we think, make the 6 inch deck beams, as well as the angles, T, and Z bars mentioned.

We remain yours respectfully,

R. W. DAVENPORT,
Superintendent.

Commodore R. W. SHUFELDT, U. S. N.,
President Naval Advisory Board, Washington, D. C.

[Shoenberger & Co., Juniata Iron and Steel Works.]

PITTSBURGH, *March* 29, 1883.

DEAR SIR: Your favor of 21st instant came duly to hand and it gives us pleasure :o tell you that we are prepared to roll any size steel plate you may require up to 100 nches in width, and at any time will be pleased to name you our lowest prices and give your orders attention.

We do not manufacture angles or bulb beams, which we understand are deck beams, but could easily furnish them to you by having them rolled here by other parties, except the 6 by 3½ angles; for these we could furnish 6 by 4.

We could also have the T bars rolled for you, but instead of 4½ by 3 we could furnish 4½ by 3½. We could also furnish 7, 8, and 9 inch deck beams, but not 6 and 10 inch, and the widest flange for both 8 and 9 inch deck beams is 4 inch, while you specify 5 inch. If, however, you would need a considerable quantity of the shapes, we could have rolls turned specially and furnish all the size shapes you specify.

Hoping we may hear from you when you are in the market,

Yours truly,

SHOENBERGER & CO.

P.S.—We would have answered you more promptly but were delayed in finding out about angles, &c.

Yours,

S. & CO.

R. W. SHUFELDT, Esq.,
Commodore, U. S. N., Washington, D. C.

It should be observed that these replies are by no means a complete re of the ability of our manufacturers to perform the work, and but one of the above firms, Messrs. Park, Bro. & Co., actually ned material in any considerable quantity under subsequent con-

difficulty of producing the required quality of material does not at this time to have received any particular attention, the chief ce of uncertainty being as to the rolling-mill capacity for some of s, and whether or not the orders would be sufficiently large to t an overhauling of machinery and the manufacture of certain rolls required.

oduction of steel plates for boiler and other purposes had reached nt proportions to prevent any difficulty attaching to the mere ing of the plates required. Several plate mills of 110 inches length ween housings were in constant use, and one 120 inches long was available if necessary. Few of the shape mills, however, had any expe- ce in working steel, except as rails, and the sufficiency of strength he rolls and connections as used for iron was a matter of some uncertainty. The rolling of steel beams of any size had never been attempted so far as we know; certainly the best shapes and arrangement of passes was a matter of discussion and even of patent. At the time of this writing a 12-inch I beam is the largest section produced in steel, and that only in one mill, and from shaped blooms.*

Still there can be no doubt of the willingness of many of the shape manufacturers to undertake any reasonably large order at a price only sufficient to cover the actual cost of production, in order to gain experience and place themselves in a position to meet any subsequent demands. In many places the fact was fully realized that in the near future there would be a rapidly increasing demand for structural steel in shapes necessary for bridge, roof, and ship construction, which is en now the case.

In the matter of quality, the Board, even at this time, recognized the fact that trouble and serious obstruction might be caused by interpret

* Rolled at the works of A. & P. Roberts, Pencoyd, Pa., on a 23-inch mill, from d blooms supplied by the Pittsburgh Steel Casting Company.

ing the statute as requiring a ductility of 25 per cent. in 8 inches as a minimum. Only two out of the nine steel manufacturers replying to the circular letter had touched at all upon the quality demanded, and these only in a general way, apparently without definite knowledge and confident that there could be nothing excessive demanded. As no objection had been made to the possible exaction of these requirements as minima, a system of tests was devised accordingly and submitted to the Department with an accompanying letter containing the opinion that these requirements were perhaps higher than necessary to secure good material and suggesting an average ductility of 25 per cent., no single test falling below 23 per cent.

The system of tests as at that time proposed is as follows:

TESTS OF STEEL FOR CRUISERS.

Instructions to inspectors.

The following rules are prescribed in order to insure the fulfillment of the clause of the act of Congress of August 5, 1882. "Such vessels * * * to be constructed of steel, of domestic manufacture, having, as near as may be, a tensile strength of not less than 60,000 pounds to the square inch, and a ductility in 8 inches of not less than 25 per centum":

I. All ship-plates, beams, angles, rivets, bolts, boiler-plates, and stays, to be inspected and tested at the place of manufacture by a naval inspector of material, and to be passed by him, subject to restrictions hereinafter mentioned, before acceptance by the ship-builders, whether Government or private, for incorporation into said vessels.

II. Every plate, beam, and angle, supplied for these vessels, to be clearly and indelibly stamped in two places, and with two separate brands: (1st) With that of the maker, which shall distinguish the name of the manufactory or company. (2d) With the regulation brand of the naval inspector of material. The latter not to be stamped upon any of the above-mentioned material until it shall have passed the required inspection and tests, have been accepted by the inspector, and have been stamped with the maker's brand.

In case of small articles passed in bulk, the above-mentioned brands shall be applied to the boxing or packing material of the objects.

No steel material to be received at the building yards for incorporation into the vessels except it bear, either upon its surface or that of its packing, both of these brands as evidence that it has passed the necessary Government inspection.

SHIP-PLATES.

III. In every lot of 20 plates test pieces to be cut from two plates taken at random; two test pieces being cut from each plate, one in the direction of the rolling, and one at right angles to it, shaped according to the annexed sketch. These test pieces shall in no case be annealed.

The test pieces to be submitted to a direct tensile stress until they break, and in a machine of approved character.

The initial stress to be as near the elastic limit as possible; which limit is to be carefully determined by the inspector in a special series of tests. The first load to be kept in continuous action for five minutes. Additional loads to be then added at intervals of time as nearly as possible equal, and separated by half a minute; the loads to produce a strain of 5,000 pounds per square inch of original section of the test piece until the stress is about 50,000 pounds per square inch of original section, when the additional loads should be in increments not exceeding 1,000 pounds.

An observation to be made of the corresponding elongation measured upon the original length of 8 inches.

The final elongation to be that obtained at rupture. The loads applied shall never be calculated from the indications of the pressure gauge if a hydraulic press be used.

In order to be accepted, a test must show an ultimate tensile strength of at least 60,000 pounds per square inch, and a final elongation in 8 inches of not less than 25 per cent. Plates which show a strength greater than 60,000 pounds per square inch will be accepted, provided the ductility remains at least 25 per cent.

If the average of these four test pieces fall below either of the required limits these plates shall be rejected and another plate from the lot shall be tested; if it fails the lot shall be rejected, and if it is successful a third test shall decide.

QUENCHING TEST.

A test piece shall be cut from *each* plate, angle, or beam, and after heating to a red, plunged in water at a temperature of 82° Fahrenheit. Thus prepared it e possible to bend the pieces under a press or hammer so that they shall be d flat, the two parts being in complete contact with each other, without pro- any trace of cracking.

e test pieces must not have their sheared sides rounded off, the only treatment ed being taking off the sharpness of the edges with a fine file.

ANGLES, BEAMS, BULB BARS, T BARS, &C.

every lot of 20 angles or beams, &c., test pieces to be cut from the webs of ken at random, one from each. These pieces to be fashioned in the same way, be subjected to the same tests, both tensile and quenching, and to fulfill the quirements for acceptance as already prescribed for ship-plates.

e bars are to be subjected to the following additional tests: A piece cut from r in twenty to be opened out flat while cold under the hammer; a piece cut other bar in the same lot shall be closed until the two sides touch while cold; from a third bar of the lot to be bent cold into a ring so that one of the sides angle bar shall be kept flat and the other side forming a cylinder, of which ernal diameter shall be equal to 3½ times the breadth of the side which remains 'he angle bars submitted to these tests must show neither cracks, clifts, nor

e T bars to be submitted to the following tests: A piece to be cut from the end r taken at random from each lot of 20, and to be bent cold into a half ring, so e web remaining in its own plane, the cross flanges shall form a half cylinder, h the internal diameter shall equal four times the height of the web of the T

e end of another bar of the same lot the web to be split down its middle for a equal three times its total depth, and a hole drilled at the end of the slit to t it spreading; the piece thus split to be opened out in its own plane, so as to n angle of 45° with the rest, care to be taken that the part opened shall be raight, except that it must be joined to the rest of the bar by a band of small

bars are to be subjected to the same tests as those prescribed for T bars, ex- at in bending one or more heats may be used.

ars submitted to these tests must show neither cracks, clifts, nor flaws.

RIVETS.

One bar from every lot of twenty of the bars from which rivets are made shall ect to the same tensile test as that required for the plate tests. All bars not g the requirements of tensile strength and elongation required for plates to be l.

every lot of 500 pounds four rivets are to be taken at random and submitted following tests, one rivet to be used for each test: 1st. A rivet to be flattened d under the hammer to a thickness of one-half its diameter without showing or flaws. 2d. A rivet to be flattened out hot under the hammer to a thickness rd its diameter without showing cracks or flaws. 3d. A rivet to be bent cold e form of a hook with parallel sides without showing cracks or flaws. 4th. A be tested by shearing by riveting it up to two pieces of steel which are to be ted to a tensile strain, the rivet not to shear under a stress of less than 50,000 per square inch.

BOILER PLATES.

Each boiler plate must be subjected to the same tests and in the manner pre- for ship-plates. The ductility in 8 inches must not be less than 25 per cent., ultimate tensile strength must not be less than 57,000 pounds and not more ,000 pounds, and the average at least 60,000 pounds.

acceptance of material under these tests will not relieve the contractor from essity of making good any material which fails in working or may be rejected inspector.

Before finally adopting this system of tests, it was deemed expe- o place it before various ship builders and steel manufacturers sted for criticism and suggestion, especially as the probability of ssels being built by contract was very strong, in which event too

much time could not be allowed intended bidders to arrive at a definite and satisfactory understanding as to their supply of material.

Accordingly copies of the preliminary scheme of tests were sent out with accompanying letter:

NAVAL ADVISORY BOARD,
Washington, April 30, 1883.

Messrs. ——— ———:

The following tests inclosed herewith have been prepared in order to insure the fulfillment of the provisions of the act of Congress of August 5, 1882, relating to the construction of steel cruisers.

The Board will be glad to receive any suggestions from you before the final adoption of these rules.

Very respectfully,

R. W. SHUFELDT,
Commodore, U. S. Navy, Prest. Naval Advisory Board.

Replies came in slowly, as follows:

[The Harlan and Hollingsworth Company.]

WILMINGTON, DEL., *May* 1, 1883.

SIR: We beg to acknowledge the receipt of your communication of the 30th ultimo, with inclosure of "Instructions to Inspectors" regarding tests of steel for cruisers.

The matter shall have our careful attention.

We are, very respectfully, yours, &c.,

J. T. GAUSE,
Vice-President.

Commodore R. W. SHUFELDT, U. S. N.,
President Naval Advisory Board, Washington, D. C.

[The Pusey & Jones Company.]

WILMINGTON, DEL., *May* 2, 1883.

DEAR SIR: We have your favor of 30th ultimo, with inclosure of memorandum of tests which it is proposed to apply to the materials to be used in the construction of the new steel cruisers.

In a very few days we shall have the pleasure of submitting our views regarding them.

Very respectfully,

PUSEY & JONES CO.,
By W. G. GIBBONS, *Prest.*

Commodore R. W. SHUFELDT, U. S. N.,
President Naval Advisory Board, Washington, D. C.

[Black Diamond Steel Works. Park, Brother & Co.]

PITTSBURGH, *May* 5, 1883.

DEAR SIR: Your printed circular, inclosed under date of April 30, marked "Tests of Steel for Cruisers," came duly to hand and contents noted.

Thanking you for this copy of "Instructions to Inspectors," we beg to advise you we have no suggestion to submit, and subscribe ourselves,

Very truly,

PARK, BROTHER & CO.

Commodore R. W. SHUFELDT, U. S. N.,
President Naval Advisory Board, Washington, D. C.

[The Pusey and Jones Company.]

WILMINGTON, DEL., *May* 8, 1883.

DEAR SIR: We confirm our advices of 2d inst.; and now further referring to your circular letter relative to the tests which it is proposed to apply to the steel to be used in the construction of the vessels called for under act of Congress of August 5, 1882, we have to say that in our opinion a measure of ductility of 25 per cent. in 8 inches is incompatible with a tensile strength of 60,000 pounds to the square inch.

The very best grades of "fire-box steel" will, under favorable circumstances, show a measure of ductility as above; but it is not often found having so high a degree of tensile strength as 60,000 pounds when associated with so great a ductility.

We are further of opinion that in view of the difficulties attending the tests as de-ibed in the afore-mentioned circular letter—that is to say, in producing steel of a de that will stand the tests successfully—very few of the steel manufacturers of country would wish to undertake the task of furnishing the plates and bars re-ed, even with the inducement of a price much above the ruling rate for ship es.

is unfortunate that Congress has so fenced in the testing of the materials as to e the procuring of them almost impossible, because steel can be had, possessing a measure of ductility, that would endure all the strains that are likely to be ap-l to the ships in question. If we can serve you further please command us.

Yours truly,

THE PUSEY & JONES CO.,
By W. G. GIBBONS,
President.

mmodore R. W. SHUFELDT, U. S. N.,
President Naval Advisory Board, Washington, D. C.

[The Midvale Steel Company.]

PHILADELPHIA, *May* 26, 1883.

EAR SIR: The Board's circular letter of April 30, regarding the proposed tests of l for cruisers, came duly to hand. We have considered the matter with care, and k that the tests prescribed should certainly insure a first-rate quality of steel for purpose in question.

he only criticism we have to make is in the test prescribed for boiler plate, which, n compared with the ship-plates in the matter of extensibility, appears to us to too low; and we think boiler-plates showing a tensile strength of from 57,000 to 00 pounds per square inch should show a greater extension than 25 per cent.

Respectfully, yours,

R. W. DAVENPORT,
Superintendent.

ommodore R. W. SHUFELDT, U. S. N.,
President Naval Advisory Board, Washington, D. C.

[Army and Navy Supplies. Austin P. Brown, agent.]

WASHINGTON, D. C., *June* 6, 1883.

IR: We have the honor to say, in answer to your letter of April 30, ultimo, re-ding steel for new cruisers, that we have no suggestions to make regarding the nted instructions to inspectors inclosed therein, as, in our opinion, they are as per-t as is possible to make them.

'ermit us to say in this connection that we are prepared to furnish ship and boiler te, to stand the required tests, at the rate of from 50 to 75 tons per day.

our letter was laid aside as not requiring an answer, and our only reason now for lying is that we are informed that you have not received all the information you ire regarding the ability of manufacturers to furnish the steel up to the full stand-required by law, as regards tensile strength and elongation.

Very respectfully, your obedient servants,

OTIS IRON AND STEEL CO.,
By AUSTIN P. BROWN, *Agent.*

dmiral R. W. SHUFELDT, U. S. N.,
President Naval Advisory Board, Navy Department, Washington, D. C.

[The Harlan and Hollingsworth Company.]

WILMINGTON, DEL., *June* 7, 1883.

EAR SIR: We have corresponded with all the manufacturers of steel in the United es regarding the tests required by the Naval Advisory Board for the steel to be in the new cruisers, and we are clear in the conviction that the rule for 60,000 nds tensile strength and an elongation of 25 per cent. in 8 inches cannot be ad-d to.

ere are very few makers of steel that admit that they can make steel to stand e tests.

e few who do admit it say that such steel will cost a great deal more money than tests were less severe.

, we fear that the difficulty will be that those parties who may obtain contracts uilding these cruisers will have to pay an exorbitant price for the steel because e severity of the tests in question.

e would suggest, to meet the difficulty, that the tensile strength be put at from

55,000 to 62,000 pounds per square inch, and that the elongation should be from 20 to 25 per cent. in 8 inches.

With this modification we believe the builders of the cruisers will be able to get steel at satisfactory prices, and from a sufficient number of makers to meet their requirements, and avoid any unnecessary delay in obtaining their materials.

Unless the tests were modified in the manner suggested, we should feel considerably embarrassed in making our bids.

Yours, &c.,

J. TAYLOR GAUSE,
President.

Hon. W. E. CHANDLER,
Secretary of the Navy, Washington, D. C.

P. S.—The following is copy of letter received, and which is a fair sample of the replies from the different makers:

"While we are prepared to make steel suitable for the purpose mentioned, yet we are not prepared to make steel that will show a uniform test of 60,000 pounds tensile strength, and a ductility of 25 per cent. in 8 inches.

"We can make steel with the ductility required, but it will not pull 60,000. Practically, steel required to have a ductility of 20 per cent. in 8 inches should range from 55,000 to 65,000, and 25 per cent. from 48,000 to 58,000.

"The Pennsylvania Railroad Company's test for boiler plate is about as good and practical as any we know of, and if, with their long experience, it is found all right for boiler plate, it ought to answer for ship plate.

"SINGER, NIMICK & CO., LTD."

[Shoenberger & Co.]

PITTSBURG, *June* 9, 1883.

DEAR SIR: Will you have the kindness to let us know regarding the matter of steel plates for steel cruisers? When will the matter be decided, and when are the contracts to be let for the plates? Your reply will greatly oblige,

Yours truly,

SHOENBERGER & CO.

Commodore R. W. SHUFELDT, U. S. N.,
Washington, D. C.

[Park, Brother & Co.]

PITTSBURGH, PA., *June* 14, 1883.

DEAR SIR: We do not think we were definite enough in our letters to you regarding quality of steel, and now write to say that we are prepared to furnish steel to stand the required test; that is, 60,000 pounds tensile strength with an elongation of 25 per cent. in an 8-inch section.

We have heard recently that your Board had under consideration the propriety of reducing the requirements and making the elongation 20 per cent. instead of 25 per cent., but we can assure you of our ability to give you steel which will stand the maximum test.

Very respectfully,

PARK, BROTHER & CO.

R. W. SHUFELDT, Esq.,
Commodore U. S. Navy,
President Naval Advisory Board, Washington, D. C.

It is seen from these replies that while most of the steel manufacturers showed willingness to supply the material demanded, the ship builders expressed strong doubts as to the necessary certainty in manufacture and fears of excessive cost.

In order to arrive at a perfectly definite and satisfactory conclusion on this subject, it became necessary to undertake a complete investigation. If it should be found that the particular provision of the law as regards tensile strength and ductility, could not be held to as low limits (the view which had hitherto been taken of it) without serious difficulty, cost, and probable delay, then, under the authority of the phrase "as near as may be," such modifications could be made as to remove the practical difficulties while obeying the spirit of the law's requirements. Accordingly the following letter was addressed to the D

rtment, recommending a reduction of the ductility requirement to 20 er cent., for the reasons given:

NAVAL ADVISORY BOARD, NAVY DEPARTMENT,
Washington City, June 11, 1883.

SIR: Referring to our letter to the Department of 26th April, suggesting tests for teel, it was stated therein "the Board considers that the ductility required by law perhaps higher than is necessary to insure good material, and will consider whether r not tests will be accepted as satisfactory which show an average ductility of 25 er cent., provided no actual test falls below 23 per cent."

In the formulation of these tests the Board considered the law as prescribing cerain fixed lower limits of strength and ductility for the hulls of the vessels, and acted ccordingly, though quite aware, as indicated in the above paragraph, that the test equired was more severe than is demanded by foreign navies and registration ocieties.

The Board now learns that though the class of material has not been commonly roduced in this country, still, as shown by the letters of steel companies, inclosed, can be manufactured.

The Board is, however, of the opinion that a first-class material would be obtained v reducing the ductility to 20 per cent., that a possible delay in construction will be s avoided, and a considerable reduction in the total cost of the vessels obtained.

If the Department authorizes this reduction, the Board recommends that the tests s thus amended, including a minor change in the quenching test, which follows necesarily upon a reduction in ductility, be inserted in the contracts.

Very respectfully,

R. W. SHUFELDT,
Rear-Admiral, U. S. N., President Naval Advisory Board.

Hon. W. E. CHANDLER,
Secretary of the Navy.

In reply, the honorable Secretary of the Navy expressed a wish to see the tests so arranged that the builders would not be at the mercy of a few steel-makers, as they feared, but considered a reduction of the ductility requirement to 20 per cent. as too great a variation from the statute, and suggested 60,000 pounds and 23 per cent. as the limits for the average of four test-pieces, with a recommendation that a lower limit of tensile strength and ductility be determined, below which no single test should fall, and suggesting 58,000 pounds and 21 per cent. for these limits.

Mr. Charles Cramp, one of the most prominent ship-builders, happening to attend soon after, stated his satisfaction with the requirements so changed and that a reduction in price would result. Under the first requirements he could obtain no quotations from makers, while in demanding under the Admiralty requirements he obtained ready replies.

The subject was again fully investigated, and, in order to appreciate the considerations governing the modifications subsequently made in the requirements as to tensile strength and ductility of ship material, it becomes necessary to follow out the comparison made with those in general use in Great Britain and France,* as given *in extenso* in the Appendix. It will suffice to state them here in general terms with reference to the opposite graphic table.

REQUIREMENTS FOR MATERIAL IN GREAT BRITAIN.

British Admiralty requirements.—A tensile strength of 26–30 tons per square inch, with a ductility of 20 per cent. in 8 inches.

Lloyd's Insurance Registry.—A tensile strength of 27–31 tons per inch, with a ductility of 20 per cent. in 8 inches.†

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* [illegible] *al* French requirements are not given in the Appendix, but only those [illegible] T[illegible]y may be sufficiently understood from the graphic table.

† [illegible] R[illegible]y within the last few years has sanctioned a reduction of ductility [illegible] 8 inches, which is now incorporated in the "Rules." (See Appen[illegible]I.)

Liverpool Underwriters' Registry.—A tensile strength of 28–32 tons per square inch, with no requirement as to ductility except that indirectly imposed by the ordinary temper and bending test.

These requirements are all extremely simple, and are supplemented by cold bending tests after heating the specimens to a red heat and suddenly cooling them in water, with such other special tests as may be desired by the inspector. The admiralty requirements had been in force since 1875, though the higher limit of tensile strength was not now rigidly adhered to. Lloyd's requirements were issued in 1877.

REQUIREMENTS OF THE FRENCH NAVY.

Although issued in May, 1876, these requirements show a thorough and masterly knowledge both of the properties of the material and of the suitable variation of quality for different parts of the structure. Nor does their apparent lack of simplicity involve any proportionate increased cost. Thus, if we should start with a sufficiently thick ingot and roll it down, at one heat, to plates of successively diminishing thickness, removing test-pieces, at each thickness within the range contained within the requirement for ship-plate, they would show successively increasing tensile strength and diminishing ductility, following very much the same law as the minimum requirements; for the plate of each successive thickness has more work on it, is finished at a lower heat, and cools more rapidly than its predecessor.*

If our ingot be not sufficiently thick, the greatest thickness will not have the greatest ductility, on account of insufficient work to remove the effects of honeycombing or blow-holes. A corresponding humoring of the difficulties of manufacture is seen in the requirements for the heaviest boiler plate, for which both less tensile strength and less ductility are required than in the next less range of thickness. For strips and straps higher tensile strength and ductility are required than for the plates which they are to connect, which is plainly in accordance with increased strength of the whole structure. For beams the tensile strength is higher and ductility lower than for plates, indicating the proper use of a somewhat harder and ultimately stiffer material. Lastly, for angles, which always have a large amount of work of reduction from the ingot and yet cool in masses, and are thereby more or less annealed, a higher tensile strength and ductility is required than for plates—qualities which would naturally be obtained in the ordinary processes of manufacture, starting from the same material in the ingot, and which are also desirable for the purposes of corner connection and stiffening served by these shapes. Under these requirements, then, the difficulties of manufacture and the efficiency of the material in the structure are, in the main, reconciled and fit into one another without friction. It is seen, therefore, that these requirements admit of complete analysis and show an excellent balance in the quality of material for each purpose served. It should also be remembered that the Siemens-Martin process, by which the mild steel first used in the French navy was exclusively produced, had received its earliest development in France, whi[illegible] an experience of three years had been obtained in the dock-yards b[illegible]

* But these qualities also promote efficiency of the structure, inasmuch as the thick plates, being generally in the skin plating (not the bottom plating, for the Frenc[illegible] at that time, from considerations of corrosion, used iron for the wetted skin) or t[illegible] notched stringer-plates, and from their very thickness suffering more in the workin[illegible] evidently require to be softer than deck plating, which is not exposed in collision li[illegible] skin plating, or than light bracket or bulkhead plating, whose chief requirement [illegible] stiffness.

fore the adoption of these requirements. Whence it would appear that they could not be too severe for good material, and might be taken as a reasonable minimum, although somewhat above the English specifications.*

MODIFICATIONS OF THE TESTS AS FIRST DRAWN UP.

The highest English specification with a ductility limit imposed was Lloyd's—a tensile strength of 60,480 pounds to the square inch, with a ductility of 20 per cent. in 8 inches. The most severe of the French requirements for ship-plate was 45 kilograms per square millimeter—63,990 pounds to the square inch—with a ductility of 20 per cent. in 200 millimeters.†

The material supplied to both must be more or less uniformly above ...irements, and was produced without difficulty by European manu...rers. There could be nothing excessively severe in a requirement, ... on that of the French navy, of a minimum tensile strength of ... pounds to the square inch, with a corresponding increase of ductil... from 20 to 23 per cent., while the average results of material made ...h specifications would reach, and probably exceed, the require...ts of the law in the quality of ductility.

...ies, it had always been the proud boast of American manufact...rs that their iron was far superior to that in general use in Europe, ... it was confidently stated that American steel deserved the same reputation.

With a change in the quenching test corresponding to the diminished ductility demanded, the final programme of tests was drawn up and approved June 18, 1883, as follows:

TESTS OF STEEL FOR CRUISERS.

Instructions to Inspectors.

NAVY DEPARTMENT,
Naval Advisory Board, June 18, 1883.

The following rules are prescribed in order to insure the fulfillment of the clause of the act of Congress of August 5, 1882—"Such vessels * * * to be constructed of steel, of domestic manufacture, having, as near as may be, a tensile strength of not less than sixty thousand pounds to the square inch, and a ductility in eight inches of not less than twenty-five per centum":

I. All ship-plates, beams, angles, rivets, bolts, boiler-plates, and stays to be inspected and tested at the place of manufacture by a naval inspector of material, and to be passed by him, subject to restrictions hereinafter mentioned, before acceptance by the ship-builders, whether Government or private, for incorporation into said vessels.

II. Every plate, beam, and angle supplied for these vessels to be clearly and indelibly stamped in two places, and with two separate brands: (1) With that of the maker, which shall distinguish the name of the manufactory or company; (2) with the regulation brand of the naval inspector of material. The latter not to be stamped upon any of the above-mentioned material until it shall have passed the required inspection and tests, have been accepted by the inspector, and have been stamped with the maker's brand.

In case of small articles passed in bulk, the above-mentioned brands shall be applied to the boxing or packing material of the objects.

No steel material to be received at the building yards for incorporation into the vessels except it bear, either upon its surface or that of its packing, both of these brands, as evidence that it has passed the necessary Government inspection.

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* The French requirements, as recently modified by the ministerial circular of February 9, 1885 [see Appendix pp. 570–573], are in closer accord with the requirements adopted by the Board.

† 8 inches = 203.2 millimeters.

SHIP-PLATES.

III. In every lot of twenty plates test pieces to be cut from two plates taken at random; two test pieces being cut from each plate, one in the direction of the rolling and one at right angles to it, shaped according to the annexed sketch. These test pieces shall in no case be annealed.

The test pieces to be submitted to a direct tensile stress until they break, and in a machine of approved character.

The initial stress to be as near the elastic limit as possible; which limit is to be carefully determined by the inspector in a special series of tests. The first load to be kept in continuous action for five minutes. Additional loads to be then added at intervals of time as nearly as possible equal, and separated by half a minute; the loads to produce a strain of 5,000 pounds per square inch of original section of the test piece until the stress is about 50,000 pounds per square inch of original section, when the additional loads should be in increments not exceeding 1,000 pounds.

An observation to be made of the corresponding elongation measured upon the original length of 8 inches.

The final elongation to be that obtained at rupture. The loads applied shall never be calculated from the indications of the pressure-gauge if a hydraulic press be used.

CONDITIONS OF ACCEPTANCE.

In order to be accepted the average of the four test pieces must show an ultimate tensile strength of at least 60,000 pounds per square inch of original section, and a final elongation in 8 inches of not less than 23 per cent.

Lots of materials which show a strength greater than 60,000 pounds per square inch will be accepted, provided the ductility remains at least 23 per cent.

CASES OF FAILURE.

If the average of these four test pieces, numbered 1, 2, 3, 4 (called Test I.), fall below either of the required limits, the plates from which pieces 1, 2, 3, 4 were cut shall be rejected, and Test II. made, consisting of pieces 5 and 6, cut from a third plate. If the mean of the results of these two fall below either of the above limits, the entire lot shall be rejected. If it be successful, Test III., or the mean of pieces 7 and 8, cut from a fourth plate, shall decide.

If in any of Tests I., II., III. any single piece shows a tensile strength less than 58,000 pounds or a final elongation less than 21 per cent., the plate from which it was cut shall be rejected and that test considered to have failed, regardless of its average.

QUENCHING TEST.

IV. A test piece shall be cut from *each* plate, angle, or beam, and, after heating to a cherry red, plunged in water at a temperature of 82° Fahrenheit. Thus prepared it must be possible to bend the pieces under a press or hammer so that they shall be doubled round a curve of which the diameter is not more than one and a half times the thickness of the plates tested without presenting any trace of cracking.

These test pieces must not have their sheared sides rounded off, the only treatment permitted being taking off the sharpness of the edges with a fine file.

ANGLES, BEAMS, BULB BARS, T BARS, ETC.

V. In every lot of twenty angles or beams, &c., test pieces to be cut from the webs of two taken at random, one from each. These pieces to be fashioned in the same way and to be subjected to the same tests, both tensile and quenching, and to fulfill the same requirements for acceptance as already prescribed for ship-plates.

Angle bars are to be subjected to the following additional tests: A piece cut from one bar in twenty to be opened out flat, while cold, under the hammer; a piece cut from another bar in the same lot shall be closed until the two sides touch, while cold; a piece from a third bar of the lot to be bent cold into a ring, so that one of the side of the angle bar shall be kept flat and the other side forming a cylinder, of which the internal diameter shall be equal to three and a half times the breadth of the side which remains flat. The angle bars submitted to these tests must show neither cracks, clifts, nor flaws.

Single T bars to be submitted to the following tests: A piece to be cut from the end of a bar taken at random from each lot of twenty, and to be bent cold into a half ring, so that, the web remaining in its own plane, the cross-flanges shall form a half cylinder, of which the internal diameter shall equal four times the height of the web of the T bar.

At the end of another bar of the same lot the web to be split down its middle for a length equal three times its total depth, and a hole drilled at the end of the slit to prevent it spreading; the piece thus split to be opened out in its own plane, so as to make an angle of 45° with the rest, care to be taken that the part opened shall be kept straight, except that it must be joined to the rest of the bar by a bend of small radius.

Bulb bars are to be subjected to the same tests as those prescribed for T bars, except that in bending one or more heats may be used.

All bars submitted to these tests must show neither cracks, clifts, nor flaws.

RIVETS.

VI. One bar from every lot of twenty of the bars from which rivets are made shall be subject to the same tensile test as that required for the plate tests. All bars not fulfilling the requirements of tensile strength and elongation required for plates to be rejected.

From every lot of 500 pounds four rivets are to be taken at random and submitted to the following tests, one rivet to be used for each test: First, a rivet to be flattened out cold under the hammer to a thickness of one half its diameter without showing cracks or flaws; second, a rivet to be flattened out hot under the hammer to a thickness one-third its diameter without showing cracks or flaws; third, a rivet to be bent cold into the form of a hook with parallel sides without showing cracks or flaws; fourth, a rivet to be tested by shearing by riveting it up to two pieces of steel which are to be submitted to a tensile strain, the rivet not to shear under a stress of less than 50,000 pounds per square inch.

BOILER-PLATES.

VII. *Each* boiler-plate must be subjected to the same tests and in the manner prescribed for ship-plates. The ductility in 8 inches must not be less than 25 per cent., and the ultimate tensile strength must not be less than 57,000 pounds and not more than 63,000 pounds, and the average at least 60,000 pounds.

The acceptance of material under these tests will not relieve the contractor from the necessity of making good any material which fails in working or may be rejected by the inspector.

R. W. SHUFELDT,
Rear-Admiral, U. S. Navy, President Naval Advisory Board.

Approved:
WILLIAM E. CHANDLER,
Secretary of the Navy.

With these provisions as regards material incorporated in the specifications under which bids were tendered, contracts were made with Mr. John Roach, representing the Delaware Iron Shipbuilding and Engine Works, Chester, Pa., and the Morgan Iron Works, of New York, on the 23d day of July, 1883, for the construction of the hulls of the Dolphin (1,500 tons), and Atlanta and Boston (3,000 tons each) and on July 26th for the Chicago (4,500 tons displacement).

PART II.

About the middle of August the first orders for material were issued from the ship-yard, and shortly after, the Board was notified by the contractor that subcontracts had been entered into with the Chester Rolling Mills, Chester Pa., Norway Iron and Steel Company, South Boston, Mass., Park Bros. and Co., Pittsburgh, Pa., for ship and boiler plate, and with the Phœnix Iron Company, Philadelphia, Pa., for angles, tees, and deck beams. Accordingly, on the 29th of August, Lieut. F. J. Drake, U. S. N., was ordered to visit Chester, Phœnixville, and Boston. to report upon the facilities afforded for carrying out the tests at each place, and to assume the duties of inspector at the latter. The facilities for testing appearing satisfactory, inspectors were ordered to each of the above-mentioned works, and to Pittsburgh, at the end of the first week in September, by which time it was expected that the manufacturers would be ready to turn out material. In addition to the general "Instructions to Inspectors" (p. 393), the following detailed instructions were issued:

DETAILED INSTRUCTIONS TO INSPECTORS OF MATERIALS.

NAVAL ADVISORY BOARD, NAVY DEPARTMENT,
Washington, September 13, 1883.

(1) The inspector will, as soon as practicable, after reaching his post, carefully examine all the appliances available for the proper inspection of material, consult with the superintendent as to making the tests, and make a special report to the Advisory Board of the kind and the efficiency of the apparatus and the arrangements which have been decided upon for making the different tests.

(2) At the end of each week he will make a general report to the Advisory Board of the work done at the foundry during the week, together with such information or suggestions as he may deem necessary in carrying out the work of inspection. At the end of each month he will send to the Advisory Board a summary of the tests made during the month, the summary being drawn up in accordance with the form hereto attached.

(3) He will keep a complete record of every piece of metal tested for the Government and for use in the construction of the new cruisers, whether such piece fulfills the requirements of a successful test or not.

(4) In case of any disagreement connected with the inspection of material, between the inspector and the superintendent of the foundry, the matter in dispute will be referred at once to the Advisory Board for settlement. It will be borne in mind that the Government has no contract with the foundry and exercises no control whatever beyond the actual inspection and stamping of the material; whilst, therefore, the inspection must at all times be strict, every effort must be made by the inspector to have it carried on with the least possible interference or delay. The superintendent of the foundry will be consulted as to the times when the different tests shoul be made, and also with regard to any modifications in the system or appliances. Th inspector will not attempt to exercise any control whatever over either the meth of manufacture or the deliveries of material.

(5) The inspector will not permit the Government mark to be placed on any materi or package intended for use elsewhere than in the building of the new cruisers, n will he permit it to be placed on any material or package that has not been inspect by him personally and fulfilled the requirements of inspection.

(6) Whilst the inspector is to use his judgment with regard to the part of t material from which the test pieces are taken, he will in no case, except by the re quest or by the permission of the superintendent of the foundry, intrench upon finished measurements of the piece in cutting his test pieces. Tests from pieces the scrap may be made, and if they fulfill the requirements the article will be passe If they fail to meet the requirements, however, the piece will not thereby be condemne All condemnations of material will be made on the failure of pieces taken from th body of the material, and the superintendent of the foundry will be notified at onc

Tensile test specimen.

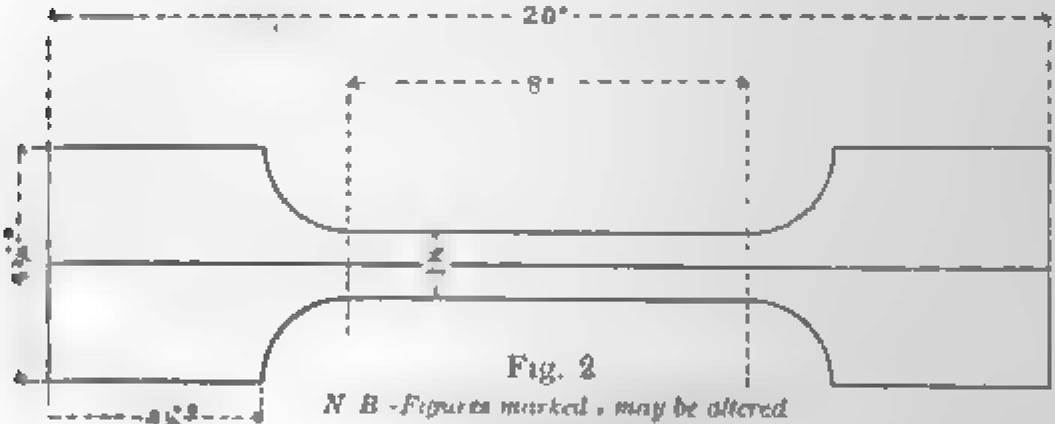

Fig. 2

*N. B.—Figures marked * may be altered to suit testing machine.*

Rivet shearing test specimen.

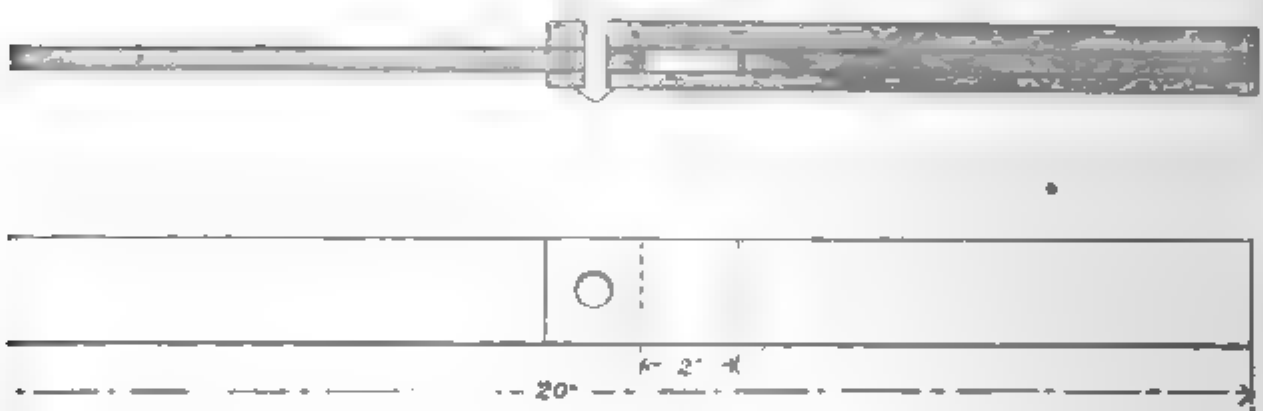

Fig. 3.

[illegible]dth of plate to be [illegible] times the diameter of the rivet. The inner [illegible] of the [illegible] to have an open space of more than 2 [illegible] between [illegible]

whenever a piece is condemned, and he will be given free access to the entire record of the test.

(7) Certain test pieces, after being tested, will be marked and carefully preserved, in such a manner and place as to be readily accessible in case of necessity for a subsequent examination or comparison. These retained test pieces will consist of: all those tested for strength and elongation; all of those used in the quenching test which are cut from the same pieces of material as the tensile pieces; all rivets and sheared rivet samples; all pieces whose tests may give rise to dispute or protest on the part of either the inspector, the manufacturer, or the building contractor; such other pieces as the manufacturer may desire to have retained.

(8) Each retained test piece will have a register mark to distinguish it, which mark will be put upon the test piece itself, painted on the proper piece of material in small characters near the Government stamp, and will form a part of the inspector's record.

(9) The register mark will consist of a number and a letter, the number to denote the lot of material, and the letter the piece in the lot. Lots of material will be numbered consecutively in the order in which they are inspected, without regard to the description of the material. As each lot consists of twenty pieces, the individual pieces will be denoted by the first twenty letters in the alphabet. In marking the tensile test pieces which are cut across the grain of the material, a small cross (x) will be affixed to the register mark. The register mark of rivet bars and rivet test pieces will consist of the lot number alone.

(10) In case that the tensile pieces are cut from the material by punching, a margin of not less than one-eighth of an inch will be left between the shoulders of the test piece, which will be removed by the file, plane, or other smooth-cutting tool, in shaping and trimming the piece. This precaution need not be followed if the piece be cut out by planing, drilling, or sawing. In the accompanying sketch of the tensile test piece the width of the breaking section is fixed at 1¼ inch. If, however, the thickness of the test piece exceeds one-half inch, the width of the breaking section will be reduced to 1 inch, and if the thickness exceeds three-fourths of an inch, the width will be reduced to the thickness of the section.

(11) In making the tensile test, it will be borne in mind that the establishment of the elastic limit is of secondary importance; therefore no attempt need be made to get it with exactitude, although care should be taken that the first stress applied to the test piece shall be below its elastic limit.

(12) Owing to the possibility of the existence of faults in the different types of testing machines that may be used at the different factories, the tensile strength and elongation records will be checked by comparison with records from Washington. To accomplish this result, the inspector will, as soon as practicable after reaching his post, have four tensile specimens prepared from a single piece of steel, chosen with special regard to homogeneity of structure. These pieces all to be cut with the grain of the material, the width of the breaking section to be one inch and its area not greater than one-half of a square inch. Two of these specimens will be carefully tested in the machine as follows: The first weight applied to give a stress of 10,000 pounds to the square inch. At intervals of one minute an additional stress of 2,000 pounds per square inch of original section will be applied until the specimen is broken. Careful measurements will be made of the elongations caused by each stress. The two other specimens (finished at the foundry exactly like the first), together with the pieces of the broken specimens and a complete record of the tests, will then be forwarded together to the president of the Naval Advisory Board at Washington, where the tests will be checked by a Rodman testing machine.

(13) No piece used in the quenching test will be less than 10 inches in length and 2 inches in width. In bending a piece the inspector will not permit any nursing on the one hand or unfairly violent treatment on the other. If bent under the hammer, the blows should be delivered square to the surface. In all cases uniformity of treatment should be observed. If practicable it would be of advantage to have the same hammer-men do all the quenching test work.

(14) In testing the shearing strength of rivets, the test piece is to consist of a double lap-joint with a single rivet arranged as shown in the accompanying sketch. The plate-steel used is in no case to be less than one fourth of an inch in thickness, and, if practicable, it should not in any case be less than one-half the diameter of the rivet, in order to insure shearing the rivet instead of the plate. The distance of the nearest edge of the rivet hole to the end of the plate is not to be less than one and one-fourth diameters of the rivet. The sharp edges of the rivet hole are not to be filed down. Snap-riveted points will in no case be allowed in the tests, but invariably the point will be thoroughly and carefully worked down. The rivet holes may be either punched or drilled as desired, and the riveting may be either by hand or machine. Great care will be exercised in testing the sample to insure a fair stress on the rivet.

(15) All instruments, books, and stationery required for use in the inspection will be procured by requisition on the Advisory Board, and receipts will be rendered to Board for all material received. Postage and telegraph expenses will only be [illegible]bursed through bills made to and approved by the Advisory Board. Expenses travel will only be reimbursed by the ordinary naval rule of mileage on orders the Department. Unless absolutely impracticable, no official expense will be [illegible]red by the inspector without preliminary authority from the Advisory Board.

(16) The inspector will be charged with ascertaining the average weight per foot of plate ordered, which will be obtained by weighing not less than 10 tons at a time when larger lots than 10 tons are delivered. In smaller deliveries than 10 tons, the whole lot will be weighed. The plates will be estimated by weight per superficial foot. The weight named will always be the greatest that will be allowed. For ship and boiler plates under 4 feet in width, a latitude of 5 per cent. below this will be allowed in plates one-half of an inch and upwards in thickness, and 10 per cent. in thinner plates. In plates for boilers over 4 feet wide and one-half of an inch thick and upwards a latitude of 2½ per cent. above and 2½ per cent. below will be allowed the springing of the rolls, and 5 per cent. above and 5 per cent. below will be [illegible]ed in thinner plates over 4 feet wide.

[illegible] inspector will consult the foundry order book for detailed information and [illegible] accept its weights and measurements as authority.

R. W. SHUFELDT,
Rear-Admiral, U. S. N., President, Naval Advisory Board.

Approved:
EARL ENGLISH,
Acting Secretary of the Navy.

Although numerous preliminary tests had been made, considerable [illegible]y was caused at first at the plate-mills by failure to meet the re[illegible]ements. At Chester and South Boston there was such fear of not [illegible]aining the required ductility that there was a decided tendency to [illegible]e a steel of too low tensile strength, a tendency further increased at [illegible]e former works on account of the mode of rapid testing with short test [illegible]ces which had been hitherto in use; and even with steel so soft the inspectors reported trouble with the quenching or temper test. At South Boston the difficulty was apparently found in the heating of the slabs before entering the plate-rolls, while considerable difference was found in the results of material from different parts of the same ingot, as given in detail, p. 532 *et seq.* At both mentioned works differences in [illegible]nper tests were reported according as the pieces were heated in an [illegible]linary heating furnace, a charcoal furnace without blast, or in a [illegible]ith's fire with blast. These difficulties were by degrees overcome, [illegible]th by greater care at the melting and heating furnaces and increasing familiarity with the tests. At the Chester Rolling Mills trouble was [illegible]so reported in consequence of the requirements for strength and duc[illegible]ility across the grain, and some delay was caused by lack of system in [illegible]rrying out the tests, while considerable opposition was experienced [illegible] account of somewhat too strong preconceived opinions as to the pro[illegible]ety of the requirements and the method of tests on the part of [illegible]se having to do with the work. The first shipment was made from [illegible]se works September 20, and from Boston September 26, and there[illegible]ter with considerable regularity.

At the Black Diamond Works, Pittsburgh, the work proceeded very [illegible]wly on account of the extreme caution of the manufacturers. Each [illegible]t was subjected to a preliminary test, and only such as appeared [illegible]isfactory were submitted to the inspector. Then, from some inexpli[illegible]ble cause, except that considerable lack of homogeneity was developed [illegible] the tensile tests, much of the material would not stand the quench [illegible]test, and it was not until October 10 that the first shipment was [illegible]e.

At the Phœnix Iron Works, Phœnixville, Pa., there was no steel

plant, blooms to the required specification being supplied by the Cambria Iron Company, with works at Johnstown, Pa., about 250 miles distant, on the Pennsylvania Railroad. Although the first order from the shipyard had been received August 17, no blooms were received until a month later, September 17, though no particular difficulty appears to have been experienced in supplying the proper quality of steel at Johnstown. But, from temporary causes, the blooms were a week to ten days in traversing the distance between the two places, and considerable time was consumed in the necessary handling Then, in endeavoring to carry out the tests, the small steam-hammers available were found inadequate for the ring test for angles, which had accordingly to be made at Chester, so that the first shipment was not made until September 28.

In consequence of the delays above mentioned, complaints were made by the contractor that on account of the severity and method of the tests, and consequent slow delivery of material, idle men and tools and empty slips were subjecting him to great additional expense. For a time determined efforts were made to break down the system of tests on the score of impracticability and expense, and it is to be regretted that these objections should have been urged as the cause of delays really due to tardiness and inexperience in manufacture.

After hearing the complaints of the contractor and certain of the steel manufacturers, the Board decided to abide by the requirements issued in accordance with the statutes, and for the fulfilment of which contracts had been made under bond, while making certain modifications in the system of tests in the direction of increased simplicity and efficiency. Accordingly, after many of these tests had been made without failure on the material delivered, the ring test was discontinued, and subsequently the close test of angles, which, being designed to detect reediness in the material, was considered unnecessary in connection with the open test. The inspector of shapes was also authorized to make the required tensile tests at Johnstown on each heat of steel, the flat pieces for test being so rolled as to have, as near as may be, the same work of reduction both of area and of thickness as in the finished shapes. The split tests for tees and deck-beams were omitted, since equivalent work was done on each end of deck-beams in forming the beam-arms in the shipyard, while, by agreement, an open and close test (see p. 542) for these shapes was substituted.

It had been urged that the arbitrary division of material into lots without regard to furnace run or heat might result in the acceptance of material not fulfilling the requirements for strength and ductility, while a failure of any lot to pass these tests would throw upon the manufacturer's hands a number of finished plates which could subsequently be disposed of only at a great loss. It was accordingly decided that a "lot of material" should consist of the total product of a furnace-heat without regard to the number of pieces, and the tensile tests be made from a plate rolled down from an ingot of the heat selected at random, the rest of the heat remaining in ingot form until acceptance under the tensile tests, in accordance with the following additional instructions:

NAVAL ADVISORY BOARD, NAVY DEPARTMENT,
Washington City, October 6, 1883.

INSPECTOR OF MATERIAL:

It having been found that the arbitrary division of material into lots of twenty pieces each may lead to the accidental acceptance of material which is not up to the requirements of tensile strength and ductility, it is decided that hereafter a lot of material shall consist of all plates and angles or other pieces which are made from the same heat.

In testing a lot the conditions of acceptance will be as prescribed in the "Tests of eel, &c.," except that instead of selecting from the finished metal a plate or bar for st, the inspector may, if the manufacturer prefer this method, select at random an got from a heat and have it, or rather a portion thereof, rolled into a plate or bar, om which test-pieces shall be cut, provided always that the same amount of meanical work is done upon them in rolling as is done upon the average finished plate or ar of the same weight per square or lineal foot.

The instructions for testing in this manner shall read as follows:

IN CASES OF FAILURE.

If the average of these four test-pieces, numbered 1, 2, 3, 4 (called Test I.), fall below ither of the required limits, the ingot from which pieces 1, 2, 3, 4 were cut shall be ejected, and Test II. made, consisting of pieces 5 and 6, cut from a second ingot or a ortion thereof. If the mean of the results of these two fall below either of the above mits, the entire lot shall be rejected. If it be successful, Test III., or the mean of ieces 7 and 8, cut from a third ingot, shall decide.

If in any of Tests I., II., III., any single piece shows a tensile strength less than 8,000 pounds, or a final elongation less than 21 per cent., the ingot from which it as cut shall be rejected and that test considered to have failed regardless of its verage.

The quenching and other tests must still be made upon the finished material as precribed.

If the manufacturers see fit to communicate the results of chemical tests to the inspectors, the Board will be glad to receive the information.

Very respectfully,

R. W. SHUFELDT,
Rear-Admiral, U. S. N., President of the Board.

Having abandoned the arbitrary division of material into lots, the tests across the grain, being now only representative of the condition of the individual plate tested, were omitted. Inasmuch as the tensile tests so made were fairly representative of the whole heat of steel, the individual test was omitted for the boiler-plates, which were tested in the same manner as ship-plate, and with the original limits of tensile strength and ductility, but omitting the required average strength of 60,000 pounds.

While omission of certain tests may be looked upon as a concession to the manufacturers, made entirely to hasten delivery and not to be repeated, in the main the changes amount to a recasting of the method for increased simplicity, and, to a certain extent, increased efficiency, while diminishing the amount of labor previously involved.

change was made in the prescribed tests for rivets, except that, the recommendation of the inspector, the pieces were riveted up single shear instead of double shear, thereby increasing the repretative value of these tests.

So amended, the system of tests was carried out on all material sub- ntly delivered, and the increasing success of the manufacturers in eting the specifications demonstrated the wisdom of the Board's con- ons that the chief difficulties and delays were due to inexperience, the almost complete absence of failures in working the material in shipyard, though by workman previously inexperienced in the treatment of steel, gave evidence of its high quality.

In the early parts of the work some difficulty was experienced in rolling light plates and angles within the prescribed limits, so that it was deemed advisable to allow plates of $12\frac{1}{2}$ pounds per square foot and less to vary between 3 per cent. above and 5 per cent. below the specified weight, and that the limits should be the same for angles of 6 pounds per lineal foot and less. The effect of this was not so much to produce material heavier than the specified weight, but, in removing the tendency to roll this material too light, the actual weights were brought more

nearly to the specified weights, on account of the increased confidence of the rollers in removing the fear of the rejection of the material were it a trifle heavy. This is a desirable condition, for in bulkhead plates and the lighter angles it is more important that the strength and stiffness designed to should be obtained than that the weight of hull should be so slightly increased.

Butt-straps, required in the specifications to be cut in the shipyard, were also allowed to be sheared out at the mills, with due regard to the direction of the grain.

In the matter of annealed material, the test pieces for tensile and cold tests, while allowed to be removed before annealing, were required to be treated in all respects like the corresponding plates, being placed in the annealing furnace along with them.

Under these arrangements, the inspection and delivery of material proceeded very satisfactorily, with the exception of the trouble with the quenching test at the Black Diamond Works, the probable cause of which will be specially considered later on.

Under a separate heading the manufacture and results of the steel produced at each of the works are given as completely in detail as appears desirable for the purposes of a general report, and, as the greater part of the material had been delivered and worked into hulls and boilers by that time, the results are given up to September 1, 1884. The information as to production, together with the chemistry of charge and product, is, in each case, as supplied by the manufacturer.

CHESTER STEEL.

(Lieuts. F. P. Gilmore and G. A. Bicknell, U. S. N., Inspectors.)

The material to be supplied consisted of boiler and ship plate made and rolled at the Chester Rolling Mills, Thurlow, Pa. The steel was made by the Siemens-Martin, or "pig and scrap," process in two 15-ton furnaces, designed by Mr. C. M. Ryder and erected in 1882, with straight high roof and curved sand bottom, 18 feet long from port to port, with hearth 12 feet long, of increasing width from port to center. The general design and arrangements of the furnaces are excellent, and embody principles only more recently developed in Europe. Siemens producers are used, but slight changes were completed in April, 1884, in one of the furnaces, adapting it to the use of vapor fuel, which, however, has not been used except for a few heats not for the cruisers.

The charge consisted of about 12 tons of pig-iron, steel scrap, shearings, muck bar, and charcoal-blooms, all charged cold in proportions based upon the indications of the tensile tests and varied from time to time.

As regards the production of this steel, Mr. P. G. Salom, chemist and superintendent of steel department, Chester Rolling Mills, in a paper before the American Institute of Mining Engineers (February, 1884), says:

"The first hundred heats, from No. 464 to No. 563, in addition to the usual amount of pig-iron, scrap, and shearings, contained charcoal-blooms and muck bar (gradually increased amounts of muck-bar and a corresponding diminution of blooms, which were at first charged in equal amounts). Nos. 564 to 619 were all made from muck-bar, with results equally if not more satisfactory than with blooms. Of the remaining heats, a few were made from all blooms, a few from all muck-bar, and the others from a mixture of the two.

Manganese was added to the bath before tapping.

The ingots were bottom cast with central runner and base plate, the izes in general use being 40 inches by 18 inches by 7 and 9 inches ck. Plates $\frac{3}{16}$ inch thick were rolled from previously rolled slabs eheated, while plates $\frac{1}{4}$ to $\frac{1}{2}$ inch thick were rolled direct from the ngot. Plates more than $\frac{1}{2}$ inch thick were rolled from ingots 10 by 4 by 60 inches and 10 by 35 by 60 inches, these two molds being considered special sizes.

It may be here observed that the thirteen reductions from a 10-inch ngot to the $\frac{3}{8}$-inch plates of the Dolphin's boiler-shells and protective leck of Atlanta and Boston, or the ten reductions to the 1-inch protective deck plates of the Chicago, are less than generally considered necessary in such cases in Europe, and the attention of the manufacturers may have to be called to the desirability of using thicker ingots, unless some method can be devised for obtaining sounder ingots without carrying too high silicon. The defects of a plate which has received too little work may not in general be detected by a few tests, and are undoubtedly rendered more apparent in flanging and working.

The mills used are 80 and 100 inches long between housings, with rolls 32 inches in diameter, in continuous connection, and driven by a Corliss horizontal engine, with 32-inch cylinder and 6-foot stroke, using steam of 70 pounds gauge-pressure, and running at about 54 revolutions, with fly-wheel 30 feet in diameter, weighing about 50 tons.

The testing machine (Fig. 4) is one of the many patterns of triple-lever machines, made by Messrs. Riehlé Bros., of Philadelphia. The straining mechanism consists of upper (the fixed) wedge-block supported by standards carried by the main frame-work, with lower block moving in slides in these standards and carried by four leading-screws attached to the cross-head of a hydraulic plunger beneath the platform of the machine. Power is applied through a hydraulic cylinder and pump, either by hand or belt and gearing, the three oil-valves being connected 120° apart to the crank-shaft, thus giving continuous motion to the lower wedge-block. The throw of the pump can also be altered to suit the nature of the work. There are primary and jockey-weight beam-arms, with adjustable compensating attachment, and connected with the straining mechanism by double levers. The primary scale is divided into increments of 2,000 pounds up to 100,000 pounds, while the jockey-weight scale is divided into intervals of 10 pounds each up to 2,000 pounds.

For flat pieces the Riehlé patent high-faced wedge (Fig. 5) is used, which, being thicker along the middle, retains the piece in line upon the first pressure being applied. For rounds double angle-faced wedges are provided. Most of the tensile tests of rivet bar were made on this machine.

The specimens for tensile tests were removed by shearing, straightened cold, and cut out in a planing machine, and were fairly well shaped. easurements for sectional area were made near each witness-mark, and in the center of the piece, in order to obtain the least value in the part to be stretched and to avoid marked differences along the length. The measured length was laid off with Brown & Sharp's long-slide mi-ometer gauge fitted with fine points, the witness-marks being light inch-marks. The thickness for sectional area at fracture was meas-ed midway between one edge and the center, but with a square-jawed iding gauge. The result on the average is believed to be very nearly orrect.

The quenching pieces were at first heated in a smith's forge with cold last, but subsequently in a small furnace attached to the annealing

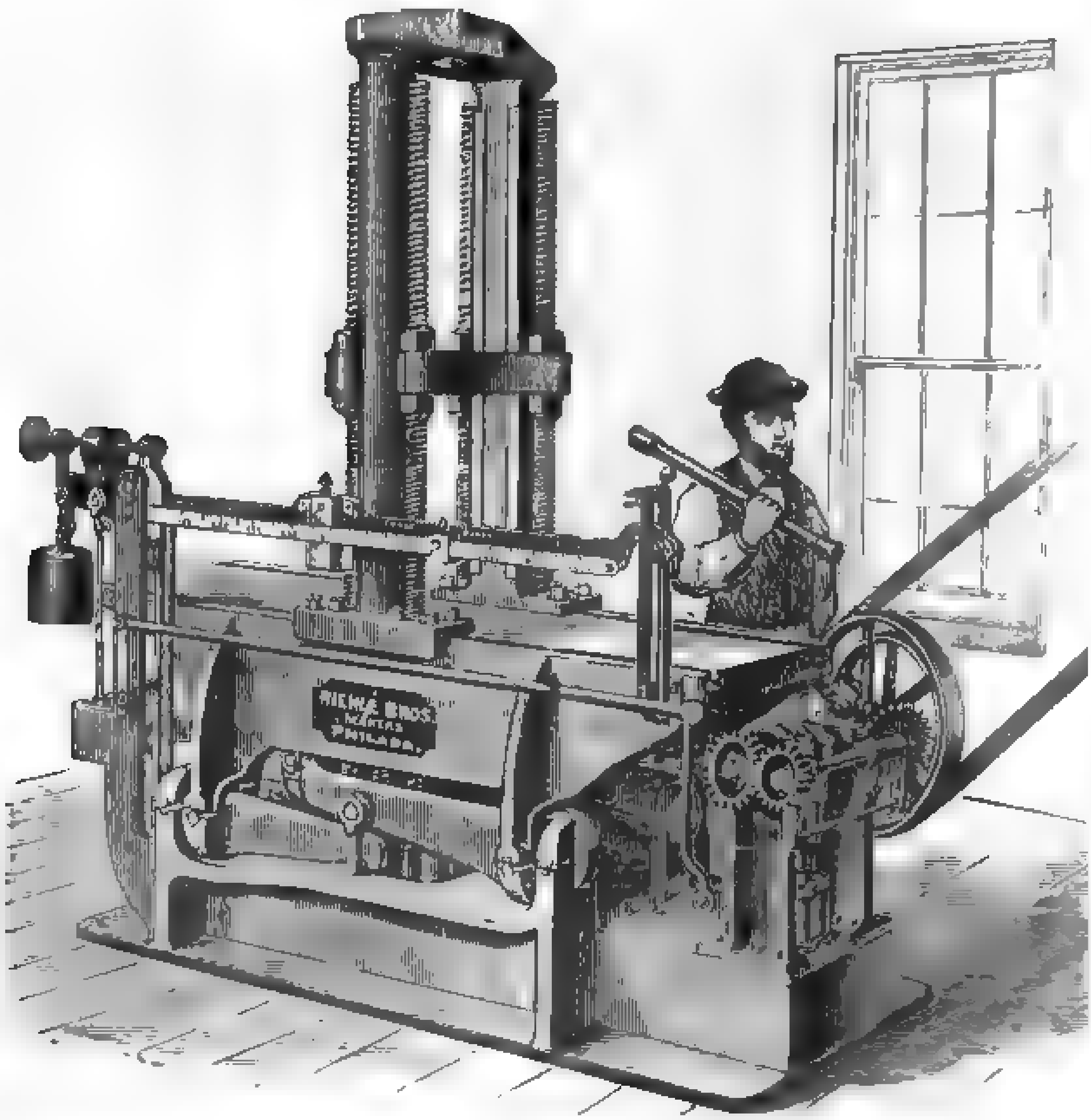

FIG. 4.—100,000 pounds Riehlé Hydraulic Testing Machine used at Chester Rolli

DIMENSIONS.

Extreme height	6 ft. 3 in.
Extreme length	6 ft. 4 in.
Extreme width	3 ft. 6 in.

Weight, 7,225 lbs.

ADAPTATION.

Tensile specimens	10 in. to 4 ft. long.
Round "	2 in. diam. or less.
Square "	2 in. x 2 in. or less.
Flat "	3 in. or less x 1 in. or less.
Transverse specimens	12 in. to 5 ft. long.
" space	3 ft. 6. in. high x 11 in. wide.
Compressive specimens	3 ft. 6 in. long or less.
" surfaces	11 in. x 11 in.
Motion of plunger	12 in.

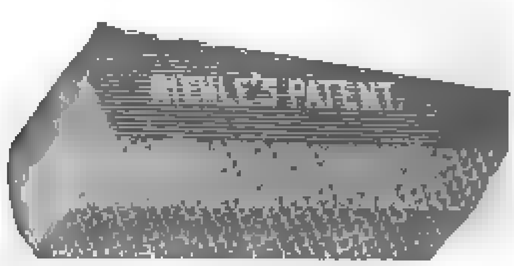

Fig. 5. High Faced Wedge.

furnace, and originally intended for annealing small pieces. A bridge 3 or 4 inches high, between the fire and the hearth, prevented the flame from playing on the pieces, and the furnace was never smoky except immediately after firing. The pieces were inserted as left curved by the shears. Lieutenant Gilmore reported a difference in the behavior of pieces under the quenching test according as they were heated in the annealing furnace or at the forge, in the latter case becoming hard to scratch with a file, and at times highly tempered, brittle, and hard to work.

After being cooled in water at 82° Fahr., they were bent smoothly in a form, as shown in Plate II., by hydraulic power, in an apparatus devised out of an old punching machine.

Sufficient chemical information accompanies the record of tests to enable the curve of carbon properties, p. 554, to be constructed, which shows graphically the average behavior of this steel under tensile test. Discussion of this curve is reserved until that of the other steels can be considered. Drillings for chemical test were taken from small test ingot, ladled from the furnace while tapping.

The chemical methods in use are—for combined carbon, the color test (p. 546, 547), dissolving a standard each time; for manganese, by dissolving in acid protosulphate of iron the binoxide precipitated from nitric-acid solution by chlorate of potash, and treating with permanganate of potash; for phosphorus, the molybdate of ammonia method, weighing the yellow precipitate of ammonia. The magnesia method was sometimes used for checking results.

The total number of heats tested to September 1, 1884, is 297, of which 60, or 20.2 per cent., were rejected on the tensile tests. In justice to the manufacturers, it should be stated that many of these rejected heats were made before the inspection was commenced, and it may be said here that nowhere throughout this report are any invidious comparisons intended of the relative success of different manufacturers in producing material to the specifications. Individual circumstances largely control appearances in such matters. Of the material so accepted 1,616.17 tons were delivered at the ship-yard up to September 1, 1884, while 14.73 tons, or 0.91 per cent., of the amount delivered, failed on the quenching test.

In the following tables the results are given in the order of heat-numbers, which was not the order of testing. This arrangement is, however, at once more convenient and better illustrates the increasing success in meeting the requirements.

For heats tested with and across the grain the separate tests are given as reported; for the others the tests with the grain are averaged.

TABLE IV.—*Tensile tests, Chester steel.*

[SYMBOLS.—A., accepted; R., rejected; F., failed; S., ship quality; B., boiler quality; — in the direction of rolling; + across the direction of rolling.]

Heat number.	Carbon.	Manganese.	Phosphorus.	Average original width.	Average original thickness.	Average original area.	Average ultimate tensile strength per square inch.	Average final elongation.	Average final area.	Number of tests.	Accepted or rejected.
	Per ct.	Per ct.	Per ct.	Inches.	Inches.	Sq. ins.	Pounds.	Per ct.	Per ct.		
329				.990	.7350	.7276	54,100	28.00	33.00	1	R.
342				.985	.7160	.7060	53,800	29.70	31.40	1	R.
345				.990	.7000	.6930	51,600	30.46	44.20	1	R.
350				1.125	.4775	.5294	54,835	25.78	43.50	4	R.*
380				1.180	.5615	.6626	62,100	28.30	47.00	2	A. S.
383				1.280	.4550	.5642	64,450	27.35	49.50	2	A. S.
398				.960	.6800	.6528	55,100	28.06	33.00	1	R.
412				.993	.6740	.6692	59,750	27.97	39.70	2	A. B.
413				1.257	.5000	.6285	60,650	25.63	47.85	2	A. S.
416				1.248	.6175	.7703	60,000	29.10	42.75	2	A. S. B.
417				.993	.5910	.5869	58,250	28.70	41.00	2	A. B.
427				1.030	.6860	.7066	54,700	29.45	33.30	1	R.
435				.963	.7120	.6856	56,680	27.81	37.80	1	R.
437				1.003	.5800	.5817	67,182	22.13	52.20	1—	R.
437				1.000	.5740	.5740	62,000	20.16	58.00	1+	
439				1.000	.7030	.7030	60,527	27.13	41.30	2	A. S. B.
440				1.092	.4910	.5355	66,850	25.00	48.95	2	A. S.
442				1.021	.5000	.5106	64,050	28.40	40.00	2	R.
443				.998	.5000	.5020	56,670	29.20	41.00	1	R.
444				1.270	.5410	.6953	56,500	27.63	47.75	2	A. B.
446				1.133	.4375	.4957	59,725	25.16	46.85	2	A. B.
451				.990	.8100	.8078	56,500	31.10	35.40	1	R.
456				.995	.4570	.4547	58,500	25.38	39.00	1	R.
459				.974	.4600	.4480	65,550	26.60	45.25	2	A. S.
461				.948	.6750	.6296	61,482	28.19	48.60	2	A. S. B.
462				.998	.6725	.6294	57,660	27.09	42.00	2	A. B.
463				1.204	.4880	.5815	66,890	24.50	50.00	1—	R.†
463				1.217	.4850	.5902	68,870	20.30	53.70	1—	
464				1.244	.4550	.5622	70,800	24.00	53.70	1—	F.
464	.19	.37	.039	1.240	.4550	.5642	70,800	18.70	54.20	1	
464	.19	.37	.039	.967	.7070	.6837	66,978	25.41	48.50	4	A. S.‡
465	.13	.38	.035	1.245	.4820	.6000	61,000	24.20	42.00	1—	A. S. B.
465	.13	.38	.035	1.250	.4820	.6025	59,580	24.72	47.00	1+	
467				.984	.5790	.5697	69,000	27.82	53.00	1—	A. S.
467				.972	.5910	.5745	67,467	21.43	55.10	1	
469				.975	.4480	.4368	62,900	28.50	45.00	1—	A. S. B.
469				1.264	.6000	.7584	61,318	26.32	46.00	1+	
470				1.250	.5900	.7375	62,047	27.28	45.00	1—	A. S. B.
470				1.250	.5950	.7437	62,570	22.44	47.00	1—	
472				1.000	.4600	.4600	60,130	37.12	42.00	1—	A. B.
472				1.000	.4630	.4630	56,000	24.27	50.00	1—	
473				1.168	.4940	.5693	59,400	28.14	41.85	2	A. B.
475				1.062	.4507	.4733	57,840	26.63	42.50	3	A. B.
477				1.248	.4410	.5504	58,150	26.75	47.45	2	A. B.
478				1.000	.6150	.6150	55,000	26.10	41.50	1	R.
479				.990	.5290	.5264	55,400	26.00	39.00	1	R.
480				1.026	.5600	.5756	59,000	28.00	48.70	1—	R.§
480				1.000	.5640	.5640	57,400	28.61	52.70	1+	
481	.11	.36		1.000	.4750	.4750	55,000	24.05	45.00	1	R.
482	.20	.38		1.060	.4950	.5266	63,825	26.70	48.50	1—	A. S.
482	.20	.38		1.000	.5040	.5380	64,500	21.00	57.00	1+	
483	.11	.36		1.255	.4850	.6041	55,200	27.60	41.30	1	R.
484	.21	.40		1.205	.4180	.5036	71,000	28.52	54.20	1—	R.
484	.21	.40		1.254	.4400	.5517	70,860	21.10	62.00	1+	
485	.11	.34		1.250	.5070	.6367	55,200	28.40	38.80	1	R.
486	.12	.37		1.135	.5000	.5675	63,685	28.43	46.20	1—	A. S. B.
486	.12	.37		1.240	.5730	.6361	61,400	22.46	57.40	1+	
487	.15	.37		1.190	.5750	.6842	60,140	27.13	48.75	1—	A. S. B.
487	.15	.37		1.249	.5460	.7219	60,950	26.06	46.50	1+	
489	.13	.40		1.246	.4810	.5903	59,240	25.81	42.10	1—	R.‖
489	.13	.40		1.254	.4730	.5926	57,880	32.18	52.60	1+	
490	.21	.56		1.287	.3300	.4023	73,500	20.75	60.00	1	R.
491	.17	.50		1.200	.4080	.5140	64,000	25.20	60.00	1—	A. S.
491	.17	.50		1.262	.4110	.5186	63,000	25.50	48.20	1+	

* Final area for 3 tests only.
† Two annealed plates accepted. See Annealing, p. 526.
‡ Retest allowed.
§ Would have been accepted for boiler metal when requirement of 60,000 pounds average tensile strength was waived.
‖ Subsequently accepted for boilers, and five plates shipped.

TABLE IV.—*Tensile tests, Chester steel*—Continued.

Heat number.	Carbon.	Manganese.	Phosphorus.	Average original width.	Average original thickness.	Average original area.	Average ultimate tensile strength per square inch.	Average final elongation.	Average final area.	Number of tests.	Accepted or rejected.
	Per ct.	*Per ct.*	*Per ct.*	*Inches.*	*Inches.*	*Sq. ins.*	*Pounds.*	*Per ct.*	*Per ct.*		
492	.13	.49	......	1.256	.2920	.3677	64,310	25.00	55.00	1−	A. S.
492	.13	.49	......	1.265	.2930	.3706	63,800	28.30	48.10	1+	
493	.16	.53	......	1.260	.5090	.6413	68,600	24.78	55.00	1	F.*
493	.16	.53	......	1.254	.3610	.4527	66,200	25.31	45.40	1−	A. S.†
493	.16	.53	......	1.250	.3670	.4587	65,600	25.06	46.80	1+	
494	.16	.50	..	1.234	.3885	.4792	65,900	24.92	46.55	2	A. S.
	.13	.49	.062	1.250	.3420	.4275	61,500	24.62	45.30	1−	A. S. B.
	.13	.49	.062	1.265	.3440	.4351	59,700	25.56	53.60	1+	
	.13	.46	......	1.254	.2960	.3701	62,900	24.50	46.00	1−	A. S.
	.13	.46	......	1.250	.3150	.3937	64,700	23.14	50.70	1+	
	.16	.49	.058	1.250	.2690	.3362	71,555	19.75	54.25	2	F.‡
	.16	.49	.058	1.113	.4720	5286	64,450	24.71	46.55	4	A. S.†
	.15	.50	.031	1.243	.3853	.4782	64,850	24.65	47.50	4	A. S.
[illegible]	.15	.49	......	1.125	.3890	.4238	64,695	25.15	47.27	4	A. S.
[illegible]	.14	.56	......	1.038	.3865	.4154	65,893	24.14	48.72	4	A. S.
	.15	.50	......	1.111	.4220	.4622	62,845	25.40	45.75	4	A. S. B.
[illegible]	.17	.58	......	1.120	.4430	.4946	72,500	23.85	56.10	4	A. S.
[illegible]	.17	.45	......	1.000	.4840	.4837	64,200	24.90	47.55	2	A. S.
	.15	.39	......	.985	.4575	.4506	61,700	27.55	42.90	2	A. S. B.
[illegible]	.14	.43	......	.977	.4850	.4738	62,125	26.65	40.90	2	A. S. B.
[illegible]	.15	.54	......	1.205	.4290	.5166	65,800	24.80	50.00	2	A. S.
	.14	.49	......	1.250	.4750	.5938	62,550	26.80	49.10	2	A. S. B.
[illegible]	.12	.53	......	1.250	.4580	.5725	62,350	26.30	47.10	2	A. S. B.
510	.15	.47	......	1.248	.4640	.5788	61,895	25.80	44.50	2	A. S. B.
511	.15	.48	......	1.000	.4725	.4725	61,150	26.55	46.95	2	A. S. B.
512	.16	.48	......	1.000	.4870	.4870	64,450	24.55	46.20	2	A. S.
513	.14	.47	......	.986	.4620	.4555	60,900	26.20	44.40	2	A. S. B.
514	.15	.40	......	.983	.4425	.4350	63,350	23.48	44.35	2	A. S.
515	.16	.53	......	1.236	.3825	.4728	68,100	24.65	51.70	2	A. S.
516	.16	.43	......	1.229	.4775	.5863	63,500	26.62	43.85	2	A. S.
517	.22	.43	......	1.247	.4480	.5584	66,075	23.74	48.00	2	A. S.
518	.19	.43	......	1.252	.4040	.5058	67,100	25.00	43.65	2	A. S.
519	.18	.49	......	.968	.4375	.4235	64,950	25.14	48.30	2	A. S.
520	.15	.46	......	.977	.6875	.6717	62,100	25.60	50.40	2	A. S. B.
521	.14	.44	......	.975	.5910	.5745	63,850	27.05	44.95	2	A. S.
522	.16	.46	......	.983	.6870	.6753	66,700	23.75	48.85	2	A. S.
523	.14	.38	......	.996	.7090	.7061	61,640	27.43	43.90	2	A. S. B.
524	.14	.39	......	.988	.7095	.7006	61,100	26.60	47.35	2	A. S. B.
525	.16	.46	......	1.245	.5290	.6586	66,450	21.77	56.35	2	R.
526	.14	.46	......	.965	.7015	.6769	60,370	24.73	48.25	2	A. S.
527	.14	.41	......	.976	.7055	.6886	63,285	24.05	50.45	2	A. S.
528	.21	.46	......	.993	.7085	.7036	74,535	24.30	50.50	2	A. S.
529	.16	.40	......	.992	.6975	.6916	62,425	25.60	48.75	2	A. S. B.
530	.18	.43	......	.983	.7015	.6892	69,650	23.13	47.80	2	A. S.
531	.16	.35	......	.997	.5760	.5740	65,745	25.07	50.80	2	A. S.
532	.17	.35	......	.982	.5545	.5442	70,570	23.90	52.30	2	A. S.
533	.14	.30	......	.979	.8350	.8070	58,815	28.00	42.25	2	A. B.
534	.12	.25	......	.975	.7170	.6987	57,275	28.40	40.50	2	A. B.
536	.11	.45	......	.908	.6965	.6319	54,100	28.64	42.50	2	R.
537	.11	.36	......	1.248	.3715	.4636	60,510	26.80	42.75	2	A. S. B.
538	.11	.24	......	1.156	.4950	.5726	56,250	29.90	37.85	2	R.
539	.14	.33	......	1.127	.4835	.5456	57,730	27.45	41.55	2	A. B.
540	.10	.31	......	1.281	.3580	.4586	62,050	24.62	50.05	2	A. S.
541	.13	.29	......	1.230	.3445	.4237	60,275	25.05	44.25	2	A. S. B.
542	.14	.36	......	1.230	.3725	.4581	60,410	27.98	49.35	2	A. S. B.
543	.15	.31	......	1.230	.4130	.5080	57,190	29.73	40.55	2	A. B.
544	.14	.27	.	1.210	.4630	.5602	54,800	30.00	43.30	1	R.
545	.13	.32	.061	1.261	.3350	.4224	54,600	28.30	44.00	1	R.
546	.14	.29	.057	1.267	.3990	.5055	58,300	27.20	44.60	2	A. B.
547	.15	.30	.058	1.259	.4300	.5413	57,450	30.85	38.50	2	A. B.
548	.16	.27	.069	1.251	.3535	.4420	59,150	29.30	40.95	2	A. B.
549	.19	.34	.069	1.118	.4440	.4914	63,300	27.70	43.50	2	A. S.
550	.15	.40	.064	1.258	.3325	.4131	63,885	28.47	45.95	2	A. S.
551	.11	.28	.075	1.250	.4320	.5400	54,900	31.25	39.10	1	R.
552	.13	.30	.075	1.157	.4125	.4770	57,750	28.64	43.75	2	A. B.
553	.11	.25	.051	1.155	.3715	.4225	52,185	30.05	37.30	2	R.
554	.16	.42	.062	1.040	.4160	.4409	60,400	28.10	43.50	2	A. S. B.
555	.14	.28	.064	1.090	.4055	.4114	59,000	28.63	43.45	2	A. B.
556	.15	.30	.043	.762	.6910	.5264	58,600	29.10	43.65	2	A. B.
557	.14	.29	.050	1.281	.3650	.4677	57,090	27.72	44.65	2	A. B.

* Quenching test failed.
† A second plate.
‡ Probably finished too cold.

TABLE IV.—*Tensile tests, Chester steel*—Continued.

Heat number.	Carbon.	Manganese.	Phosphorus.	Average original width.	Average original thickness.	Average original area.	Average ultimate tensile strength per square inch.	Average final elongation.	Average final area.	No. of tests.	Accepted or rejected.
	Per ct.	*Per ct*	*Per ct.*	*Inches.*	*Inches.*	*Sq. ins.*	*Pounds.*	*Per ct.*	*Per ct.*		
558	.15	.38	.046	1.255	.3800	.4770	63,100	23.67	51.85	2	A. S.
559	.16	.27	.052	1.023	.3465	.3543	57,850	28.80	40.15	2	A. B.
560	.11	.30	.052	1.023	.3240	.3314	56,400	29.06	40.00	1	R.
561	.16	.39	.039	1.030	.4835	.4980	60,490	26.12	48.05	2	A. S. B.
562	.16	.28	.050	.990	.4725	.4678	57,750	29.05	41.55	2	A. B.
563	.14	.33	.044	.994	.4610	.4582	57,650	29.30	41.85	2	A. B.
564	.16	.40	.037	1.311	.3505	.4595	58,500	25.25	41.50	2	A. B.
565	.18	.39	.038	.990	.5390	.5336	60,545	28.45	43.55	2	A. S. B.
566	.20	.41	.039	.980	.5275	.5169	59,000	29.27	41.85	2	A. B.
567	.17	.27	.050	1.021	.5335	.5447	58,545	29.45	39 50	2	A. B.
568	.17	.42	.044	1.026	.4975	.5102	61,900	27.72	45.80	2	A. S. B
569	.17	.44	.042	1.026	.3590	.3683	66,200	23.04	56.50	2	A. S.
570	.17	.42	......	1.019	.3725	.3795	63,600	29.62	46.40	2	A. S.
571	.16	.41	.047	1.028	.5945	.6111	62,900	23.84	55.60	2	A. S.
572	.15	.37	.053	1.032	.5650	.5831	57,570	29.68	46.75	2	A. B.
573	.17	.29	039	1.042	.7000	.7290	59,400	26.74	53.40	2	A. B.
574	.14	.35	.038	1.037	.7010	.7267	57,100	28.70	41.60	2	A. B.
575	.13	.30	.042	.828	.5685	.4704	59,350	26.55	40.85	2	A. B
576	.14	.36	.018	.993	.5650	.5552	61,300	26.95	41.10	2	A. S. B.
577	.14	.39	.033	.970	.5500	.5335	57,050	30.45	39.00	2	A. B.
578	.14	.40	.050	.917	.5535	.5074	57,880	30.25	38.55	2	A. B.
579	.15	.37	.047	.794	.5465	.4339	60,100	26.95	41.45	2	A. S. B.
580	.17	.41	.042	.882	.7095	.6255	60,215	25.01	41.95	2	A. S. B.
581	.14	.33	.047	1.110	.7080	.7856	58,550	29.87	42.75	2	A. B.
582	.15	.36	.048	1.098	.5725	.6283	57,850	30.84	48.50	2	A. B.
583	.15	.32	.055	1.265	.5490	.6945	57,215	31.45	46.40	2	A. B.
584	.....	.....	.....	1.258	.4735	.5954	78,100	22.61	58.00	2	R.
585	.....	.....	.....	1.252	.4665	.5845	66,050	26.30	45.85	2	A. S.
586	.13	.33	.052	1.248	.4725	.5894	58,610	26.10	46.40	2	A. B.
587	.14	.33	.046	1.244	.4725	.5880	60,900	27.90	49.50	2	A. S. B.
588	.16	.43	.048	1.247	.4990	.6223	61,600	25.15	43.15	2	A. S. B.
589	.16	.49	.046	1.305	.4730	.6173	64,850	24.75	48.15	2	A. S.
590	.14	.39	.052	1.220	.4835	.5898	62,700	25.75	46.50	2	A. S. B.
591	.....	.46	.0?9	1.242	.4890	.6071	64,650	25.96	50.85	2	A. S.
592	.14	.41	.045	1.228	.5185	.6367	65,590	25.30	57.55	2	A. S.
593	.19	.44	.054	1.280	.5040	.6449	62,500	25.65	51.50	2	A. S. B.
594	.15	.42	.052	1.275	.4920	.6221	62,550	27.58	50.90	2	A. S. B.
595	.13	.36	.046	1.260	.4465	.5626	58,750	27.25	45.30	2	A. B.
598	.12	.34	.054	1.234	.5015	.6186	56,550	27.65	42.35	2	R.
599	.....	.....	.....	1.218	.5075	.6183	32,500	.....	.....	2	R.*
600	.18	.40	.060	1.242	.5015	.6229	65,950	22.10	51.10	2	R.
601	.18	.37	.048	1.224	.4825	.5903	64,750	25.25	52.60	2	A. S
603	.19	.73	.056	1.256	.4945	.6216	69,700	21.50	61.85	2	R.†
605	.17	.50	.044	1.185	.4390	.5202	64,600	24.45	60.60	2	A. S
606	.14	.47	.042	1.175	.5090	.5980	65,000	19.70	60.00	1	R.
607	.15	.29	.018	.953	.7058	.6721	65,350	24.08	53.92	4	A. S.
608	.16	.27	.043	1.209	.5090	.6152	60,050	25.20	46.00	2	A. S. B
609	.15	.29	.052	1.237	.5095	.6303	63,250	23.22	53.30	4	A. S.
610	.15	.38	.062	1.219	.4745	.5784	64,950	27.05	48.50	2	A. S.
611	.17	.38	.047	1.212	.4735	.5747	64,850	25.56	53.65	2	A. S.
612	.16	.32	.065	1.238	.4815	.5963	62,500	23.54	52.77	4	A. S.
613	.16	.39	.061	1.245	.4565	.5681	62,950	23.75	54.50	2	A. S.
614	.16	.30	.051	1.240	.4590	.5692	61,000	27.55	51.10	2	A. S. B.
615	.17	.41	.051	1.244	.4715	.5866	62,350	26.15	50.25	2	A. S. B
616	.16	.41	.057	1.264	.5000	.6320	62,050	26.60	47.50	2	A. S. B
618	.15	.45	.057	1.260	.5130	.6464	67,050	23.25	58.70	2	A. S.
619	.16	.36	.059	1.263	.5500	.6947	63,050	26.05	62.00	2	A. S.
620	...	.....	.....	1.254	.4985	.6249	73,000	23.30	55.30	2	A. S.
621	.15	.36	.048	1.247	.5425	.6763	62,750	24.85	48.80	2	A. S.
622	.17	.47	.051	1.250	.5395	.6744	63,350	26.57	51.25	2	A. S.
623	.15	.43	.060	1.246	.4835	.6023	63,300	26.75	52.80	2	A. S.
624	.15	.41	.052	1.249	.4860	.6066	68,200	27.44	52.05	2	A. S.
625	.16	.38	.061	1.260	.4665	.5879	66,300	25.60	51.25	2	A. S.
626	.19	.33	.045	1.258	.4650	.5849	68,070	23.10	53.22	4	A. S.
627	.19	.41	.050	1.250	.5110	.6388	71,700	25.20	56.45	2	A. S.
628	.12	.36	.053	1.250	.4940	.6175	58,000	26.40	48.70	2	A. B
629	.....	.....	.....	1.218	.5200	.6176	61,700	25.50	51.50	2	A. S.
630	.13	.49	.048	1.176	.5218	.6158	60,720	23.15	52.65	2	A. S.
631	.17	.44	.051	1.225	.4905	.5991	63,550	23.46	56.65	2	A. S.
632	.14	.34	.052	1.194	.4745	.5663	63,000	26.10	52.00	2	A. S.
633	.15	.41	.047	1.207	.4950	.5975	58,600	25.65	45.75	2	A. B.

* Broke in grips: cryst. fract. † Fracture laminated.

TABLE IV.—*Tensile tests, Chester steel*—Continued.

Number.	Carbon.	Manganese.	Phosphorus.	Average original width.	Average original thickness.	Average original area.	Average ultimate tensile strength per square inch.	Average final elongation.	Average final area.	No. of tests.	Accepted or rejected.
	Pr. ct.	Pr. ct.	Pr. ct.	Inches.	Inches.	Sq. ins.	Lbs.	Per ct.	Per ct.		
....	.16	.45	.051	1.233	.5000	.6163	61,650	25.00	50.55	2	A. S.
....	.13	36	.056	1.206	.4875	.5879	57,230	26.20	47.75	2	A. B.
....	.15	.39	.051	1.199	.4825	.5785	59,350	23.47	50.50	2	R.
....	.13	.31	.049	1.198	.4810	.5762	52,750	27.75	46.75	2	R.
....	.14	.39	.049	1.255	.5305	.6655	66,150	23.75	57.70	2	A. S.
....	.13	.36	.050	1.248	.5230	.6524	57,440	26.80	48.50	2	A. B.
....	.13	.30	.049	1.258	.4900	.6162	59,000	28.05	49.60	2	A. B.
....	.14	.42	.054	1.277	.4950	.6321	63,200	25.45	52.85	2	A. S.
....	.12	.24	.047	1.273	.4915	.6254	56,900	27.30	45.55	2	R.
....	.15	.30	.040	1.284	.4850	.6225	61,100	28.40	47.75	2	A. S. B.
....	.15	.41	.055	1.263	.4990	.6298	60,600	26.55	50.80	2	A. S. B.
....	.13	.33	.061	1.234	.5045	.6223	58,150	27.85	51.00	2	A. B.
....	.15	.33	.050	1.243	.4985	.6196	59,300	26.15	52.00	2	A. B.
....	.12	.38	.048	1.243	.4540	.5641	58,850	26.25	50.25	2	A. B.
....	.14	.34	.042	1.225	.5205	.6375	61,750	24.35	51.90	2	A. B.
....	.16	.31	.059	1.216	.4945	.6010	64,200	26.30	52.00	2	A. S.
....	.16	.29	......	1.242	.5130	.6371	61,915	27.45	48.00	2	A. S. B.
....	.16	.31	......	1.236	.4890	.6044	66,500	19.95	59.00	2	R.
....	.16	.31	......	1.182	.5293	.6256	63,617	24.57	49.67	3	(*)
....	.12	.27	......	1.199	.4925	.5768	67,250	23.35	56.00	2	A. S.
....	.12	.27	......	1.196	.4900	.5725	60,850	27.75	41.00	2	A. S. B.
....	.12	.33	......	1.180	.4925	.5811	62,800	29.40	44.00	2	A. S. B.
....	.13	.32	......	1.194	.5000	.5968	63,800	24.85	46.05	2	A. S.
....	.16	.38	......	1.200	.5165	.6356	67,200	27.50	50.65	2	A. S.
....	.15	.37	......	1.217	.5125	.6031	61,750	25.50	46.15	2	A. S. B.
....	.13	.33	......	1.238	.5150	.6374	60,750	24.45	48.60	2	A. S,
....	.17	.34	....	1.227	.5100	.6255	67,000	23.95	50.65	2	A. S.
....	.17	.36	....	1.220	.5185	.6326	65,150	24.75	48.10	2	A. S.
....	.12	.31	......	1.215	.4850	.5892	60,490	26.25	45.75	2	A. S. B.
....	.13	.31	....	1.207	.4820	.5815	62,000	27.95	44.50	2	A. S. B.
....	.15	.37	......	1.097	.5365	.5883	61,200	26.75	43.75	2	A. S. B.
....	.14	.35	......	1.091	.4950	.5398	60,450	30.25	41.00	2	A S. B.
....	.13	.29	......	1.226	.4870	.5970	62,975	28.40	41.00	2	A. S. B.
....	.11	.29	......	1.227	.5500	.6754	59,700	29.65	40.50	2	A. B.
....	.14	.30	......	1.240	.5075	.6294	60,800	26.05	43.00	2	A. S. B.
....	.15	.34	......	1.239	.5185	.6424	62,300	27.25	44.25	2	A. S. B.
....	.13	.32	......	1.227	.4935	.6055	60,200	30.30	43.75	2	A. S. B.
....	.14	.35	......	1.227	.5365	.6545	63,200	27.50	46.13	2	A. S.
....	.16	.29	......	1.236	.4995	.6174	65,450	28.70	47.00	2	A. S.
....	.14	.34	......	1.238	.5195	.6428	62,650	29.25	44.00	2	A. S. B.
....	.14	.34	......	.983	.5045	.5005	56,600	26.15	42.15	2	R.
....	.13	.29	......	.976	.4915	.4802	57,050	25.45	44.70	2	A. B.
....	.12	.24	......	1.018	.5050	.5408	54,450	27.50	40.45	2	R.
....	.12	.30	......	1.080	.4825	.5018	55,350	27.25	42.65	2	R.
....	.12	.28	......	1.096	.4980	.5458	54,915	29.30	42.70	2	R.
....	.12	.32	......	1.069	.5120	.5468	57,500	28.95	46.00	2	A. B.
....	.12	.38	......	1.082	.4920	.5326	57,350	26.65	42.25	2	A. B.
....	.15	.37	......	1.137	.5470	.6217	59,340	24.80	46.35	2	R.
....	.14	.35	......	1.163	.4860	.5688	60,250	29.15	45.60	2	A. S. B.
....	.16	.39	......	1.155	.5035	.5816	60,850	24.70	51.10	2	A. S.
....	.15	.40	......	1.130	.5025	.5678	60,100	25.90	53.55	2	A. S. B.
....	.14	.36	......	1.134	.5000	.5670	58,750	25.00	51.15	2	A. B.
....	.15	.44	....	1.035	.5150	.5331	60,480	25.35	48.70	2	A. S. B.
....	.14	.37	......	1.067	.4820	.5140	58,070	25.65	46.00	2	A. B.
....	.14	.35	......	1.147	.5075	.5562	57,750	26.55	49.50	2	A. B.
....	.15	.36	....	1.124	.5155	.5794	62,785	25.95	53.50	2	A. S. B.
....	.16	.37	......	1.090	.5890	.6420	60,170	24.15	47.80	4	A. S.
....	.16	.44	......	1.075	.5010	.5518	63,250	25.40	52.50	2	A. S.
....	.16	.44	......	1.023	.4895	.5005	61,585	24.20	47.10	2	A. S.
....	.14	.42	......	1.042	.4820	.5020	60,505	26.35	48.50	2	A. S. B.
....	.16	.48	......	1.033	.4790	.4946	63,500	26.25	49.55	2	A. S.
....	.16	.40	......	1.143	.5325	.5991	61,665	25.35	49.35	2	A. S. B.
....	.16	.39	......	1.025	.5365	.5496	60,315	25.15	47.83	2	A. S. B.
....	.15	.41	......	1.043	.5450	.5680	58,075	28.70	42.00	2	A. B.
....	.16	.39	......	1.056	.5300	.5597	61,795	26.10	45.00	2	A. S. B.
....	.16	.45	......	1.101	.4780	.4784	60,325	26.90	48.10	2	A. S. B.
....	.15	.35	......	.961	.5175	.4971	61,135	25.20	46.00	2	A. S. B.
....	.15	.40	......	1.317	.4875	.6418	60,365	23.75	50.90	2	A. S.
....	.15	.37	......	1.353	.5000	.6763	57,550	24.85	44.70	2	R.
....	.16	.38	......	1.005	.5000	.5025	61,100	23.80	45.40	2	A. S.
....	.16	.39	......	1.087	.5083	.5521	59,225	26.55	48.00	4	R.†
....	.14	.34	......	1.029	.5050	.5196	58,400	28.35	41.50	2	A. B.
....	.17	.41	......	1.029	.5150	.5297	62,250	25.55	48.00	2	A. S. B.

* Test plate only accepted. † Two pieces gave less than 57,000 pounds.

TABLE IV.—*Tensile tests, Chester steel.*—Continued.

Heat number.	Carbon.	Manganese.	Phosphorus.	Average original width	Average original thickness.	Average original area.	Average ultimate tensile strength per square inch.	Average final elongation.	Average final area.	No. of tests.	Accepted or rejected
	Perct.	*Perct.*	*Perct.*	*Inches.*	*Inches.*	*Sq. ins.*	*Pounds.*	*Per ct.*	*Per ct.*		
717	.17	.46	......	1.160	.5195	.6023	63,050	24.35	49.50	2	A. S.
718	.16	.28	......	1.128	.4875	.5497	61,500	23.00	48.00	2	A. S.*
719	.16	.35	......	1.106	.5155	.5702	60,850	24.50	34.70	2	A. S.
720	.16	.43	......	1.094	.5135	.5618	61,000	23.44	44.50	2	A. S.
721	.17	.40	......	1.022	.5100	.5210	60,500	25.30	51.00	2	A. S. R.†
722	.15	.44	......	1.015	.5105	.5183	60,250	25.40	47.30	2	A. S. R.
723	.17	.47	......	.998	.5050	.5038	60,300	24.60	46.50	2	A. S.
724	.17	.46	......	.995	.5165	.5139	61,750	22.50	45.62	2	A. S.
725	.13	.22	......	1.224	.5325	.6516	55,200	28.70	43.60	2	R.
726	.12	.22	......	1.222	.5275	.6446	56,200	26.35	42.00	2	R.
727	.11	.41	......	.990	.4770	.4722	63,000	21.20	48.00	2	R.
728	.16	.42	......	1.027	.5030	.5218	62,250	18.20	48.00	2	R.
729	.13	.80	......	1.020	.5110	.5212	60,850	22.40	45.00	2	A. S.
730	.14	.20	......	1.015	.5135	.5183	62,000	23.85	41.00	2	A. S.
731	.14	.38	......	.909	.5075	.5065	63,850	23.95	49.00	2	A. S.
732	.13	.38	......	1.032	.5188	.5350	61,300	23.20	50.00	4	A. S.
733	.15	.48	......	1.046	.5200	.5497	63,850	23.90	47.00	2	A. S.
734	.16	......	......	1.013	.5425	.5467	62,650	24.10	47.00	2	A. S.
735	.10	.40	......	.993	.4960	.4925	65,000	26.60	41.50	2	A. S.
736	.15	.41	......	1.125	.5275	.5910	61,750	24.30	42.00	2	A. S.
737	.15	.40	......	1.110	.5250	.5830	62,000	25.10	45.00	2	A. S. R.
738	.15	.48	......	1.053	.5188	.5465	64,275	22.58	47.25	4	R.
739	.15	.40	......	1.080	.5450	.5890	63,400	24.60	40.00	2	A. S.
740	.15	.39	......	1.080	.5250	.5670	63,400	25.05	41.00	2	A. S.
741	.15	.41	......	1.098	.5125	.5620	62,500	25.25	42.00	2	A. S. R.
742	.12	.42	......	1.023	.5225	.5340	61,200	24.85	44.00	2	A. S.
743	.14	.45	......	1.026	.5063	.5195	61,075	22.63	43.00	4	R.
744	.12	.39	......	.978	.5275	.5160	59,050	22.35	45.00	2	R.
745	.12	.36	......	1.050	.4543	.4770	61,100	23.40	45.00	2	A. S.
746	.15	.41	......	.968	.5415	.5240	63,500	19.85	55.00	2	R.
747	.15	.20	......	.943	.5000	.4720	63,800	24.45	47.00	2	A. S.
748	.15	.40	......	1.027	.5030	.5165	63,925	22.58	45.00	4	R.
749	.13	.41	......	1.050	.4900	.5150	63,600	25.00	42.00	2	A. S. R.
750	.13	.38	......	1.043	.4880	.5090	64,200	20.65	50.50	2	R.
751	.14	.30	......	.899	.4933	.4435	63,425	22.83	46.75	4	R.
752	.14	.41	......	1.008	.5025	.5210	61,100	23.25	48.50	2	A. S.
754	.14	.39	......	1.038	.4925	.5110	62,000	24.00	47.50	2	A. S.
755	.14	.40	......	.955	.5100	.4875	60,500	24.15	45.00	2	A. S.
756	.13	.26	......	.939	.5135	.4826	57,650	24.45	40.00	2	R.
757	.13	.31	......	.960	.5025	.4925	58,650	23.70	41.00	2	R.
758	.12	.27	......	.963	.4980	.4896	56,860	24.65	41.00	2	R.
759	.13	.31	......	.970	.5565	.5393	61,480	22.05	48.00	2	A. S.
767	.14	.45	......	.982	.4950	.4860	60,700	25.35	50.50	2	A. S. R.

* Rough surface.

† One piece had rough surface.

NORWAY STEEL.

(Inspector, Lieutenant F. J. Drake, U. S. N.)

The material to be supplied consisted of ship and boiler plate. The steel was made at the Norway Steel and Iron Works, South Boston, and rolled into slabs, as hereafter described, being reheated and rolled into plate at the Bay State Iron Works, about a mile and a half distant.

At the end of 1883, the firm of Naylor & Co., previously controlling the Norway Works, was dissolved, and the works passed into the hands of a stock company, known as the Norway Steel and Iron Company with a change of officers and foremen. Beyond the time consumed in overhauling the furnaces no delay was caused, the new company continuing the contracts. The drop in the heat-numbers in the table of tests was due to this change of management.

steel was produced by the Siemens-Martin, or "pig and scrap" , in three 10-ton furnaces, erected in 1873, and of the following limensions:

	Ft.	In.
n plane of ports	13	0
ront to back ports	7	3
crown to bed-floor	4	4

s supplied to each furnace by a group of four Siemens producers, ed in a rectangle, with central shaft, and each group supplied eam-blast from an independent boiler.

Heat No. 1892 to No. 2411, inclusive, the charge consisted usu about one-eighth preheated Lonsdale pig, one-half puddle balls, ree-eighths shearings and pit * and wrought iron scrap.

Heat No. 39, and subsequently, the composition was variable. average weight of charge was 18,000 pounds.

-manganese was added to the bath about seven minutes before g; up to Heat No. 2411 from 130 to 160 pounds, subsequently 250 pounds.

average time of a heat from charging to tapping was between d a half and six hours.

June 14, 1884, including all heats between No. 1892 and No. l ingots were top cast. Thence to August 1, some were top ne bottom cast, and subsequently, including all heats after No. bottom cast was alone used.

molds in general use measured: inside, top 12 by 20½ inches; , 13 by 21½ inches; depth, 60 inches, corresponding to a capacity t 4,370 pounds. The ingots were stripped at a cherry heat, wash and bloomed down to slabs from 4 to 7 inches thick and 21 wide, in a three high mill with collared rolls 58 by 30 inches, by a vertical condensing Corliss engine, 42 by 42 inches, of about I. P., and using steam of 70 pounds, gauge pressure. These e cut to length as required and sent to the Bay State Mills.

ll be observed that the average thickness of the ingots, 12½ gives 25 per cent. more reduction than at the Chester Mills, s better practice, though much depends on the conditions of

r molds, 8 by 26 by 60 inches and 10 by 26 by 60 inches, are ally used, and the corresponding ingots rolled down without ng.

ghout the supply of material under this inspection the upper the ingot was generally discarded on account of the unsatisfac sults obtained by special experiment on the corresponding rolled s described, p. 532, *et seq.*

e Bay State Mills, the plate train is two high, 110 by 30 inches, three-high mill, 91 by 30 inches, is used for finishing plates of n 15 pounds per square foot. Both mills are driven from a horizontal condensing simple engine, 39 inches diameter of cyl by 6 feet stroke, developing as high as 800 I. H. P.

steel was tested at the Norway Works on a Riehlé hydraulic e of general design as shown in Fig. 6, of 50,000 pounds capac r and in good order. It is worked by hand through a single o a ram in the lower casing, the load being transmitted through e to a lever in the upper casing between stanchions, thence to n lever at the top, thence down one stanchion to a third lever in

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*rap consists of the "skull," or layer of steel left on the bottom and sides of , the overflow of ingots, leakage into the pit, runners, &c.

the casing under the pump, thence up the scale stanchion to the s
beam. The beam is fitted with primary and jockey weights, rea
to 10 pounds, and has adjustable compensating attachment. The g
consist of high-faced wedges $5\frac{1}{2}$ by $3\frac{1}{4}$ inches. The packings gave
quent trouble from leakage, necessitating stoppage and overhaulin

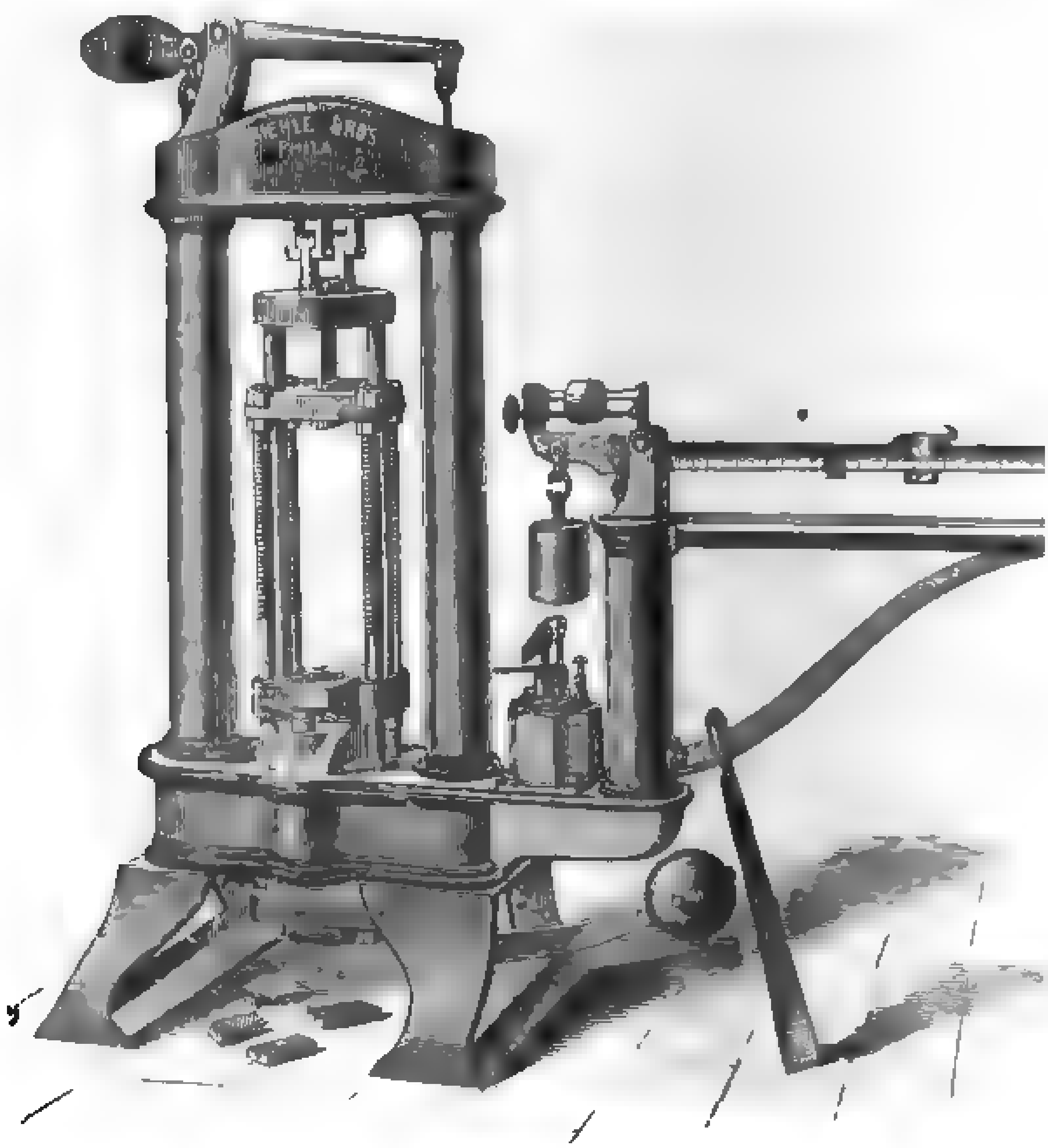


FIG. 6.—50,000 lbs. Riehlé Hydraulic Testing Machine used at Norway Iron and Works and at Black Diamond Steel Works.

DIMENSIONS.

Extreme height	8 ft.
Extreme length	7 ft.
Extreme width	2 ft. 6 in.
Weight	2,250 lbs.

ADAPTATION.

Tensile specimens	6 in. to 24 in. long.
Round specimens	1 in. diam. or less.
Square "	1 in. x 12 in. or less.
Flat "	2 in. or less x [illegible] in. or less.
Transverse specimens	12 in. long.
Compression "	20 in. high or less.
" surfaces	6 in. x 6 in.
Motion of plunger	8 in.

ieces for tensile test were straightened cold from the bent shear- out on a planer, and laid off and measured before and after with Brown & Sharp's gauges. The mean of several measure- as taken for thickness of fractured area.

ieces for quenching test were cold straightened as left by the and generally heated at a smith's forge, about twelve at a time or three deep, in an arched coke fire with closed mouth, but es on a flat fire under a board with slight blast. On cooling in 82° F., they were bent under a steam-hammer with a light uni- oke.

ent chemical information accompanies the report of tests to he curve of carbon properties (p. 555) to be constructed, thus graphically the average behavior of this material under the ests.

hemical methods in use are:—for carbon, the color test; for ese, a volumetric process devised by the chemist of the Norway Mr. H. C. Babbitt, taking only from ten to fifteen minutes for nd said to give results which agree well with determinations of chemists using the more common methods. Occasional checks ganese are also made by the nitric acid and chlorate of potash

tal number of heats tested up to September 1, 1884, is 369, of l or 18.7 per cent. were rejected. Of the 308 heats accepted for boiler plate, the average tensile strength per square inch is ounds, with a corresponding ductility of 25.56 per cent. in 8 Of the material so accepted, 1,616.22 tons were delivered at yard up to September 1, 1884, while 13.75 tons or 0.85 per cent. nount delivered was rejected on the quenching test. The per- of loss due to rolling and shearing here is estimated at 27 per

al interesting special tests were made on this steel, which will l later on under appropriate headings.

following table the tests are arranged in the order of heats. e noticed that many of the earlier heats, which were too soft plate, for which they were run, would have met the require- r boiler metal, not at that time ordered.

TABLE V.—*Tensile tests Norway steel.*

ber.	Carbon.	Manganese.	Phosphorus.	Average original width.	Average original thickness.	Average original area.	Average ultimate tensile strength per square inch.	Average final elongation.	Average final area.	Number of tests.	Accepted or rejected.
	Perct.	*Perct.*	*Perct.*	*Inches.*	*Inches.*	*Sq. ins.*	*Pounds.*	*Per ct.*	*Per ct.*		
......	.14	.36	......	.770	.561	.432	57,779	29.0	48.0	8	R.
......	.13	.32	......	1.002	.524	.524	61,500	27.0	43.0	4	A.
......	.12	.52	......	.992	.420	.417	67,200	22.0	49.0	6	R.
......	.12	.48	......	1.049	.520	.545	58,810	26.5	58.0	6	R.
......	.15	.37	......	1.044	.525	.548	58,276	26.0	53.0	8	R.
......	.14	.47	......	1.003	.423	.426	65,200	23.0	49.0	8	R.
......	.16	.43	......	1.049	.447	.467	61,660	27.0	62.0	4	A.
......	.13	.42	......	1.001	.465	.465	64,300	20.5	61.0	6	R.
......	.13	.39	......	1.006	.526	.530	60,987	25.0	52.0	4	A.
......	.12	.42	......	.977	.442	.415	57,200	26.0	51.0	8	R.
......	.15	.47	......	1.004	.451	.453	61,090	24.0	51.0	6	R.
......	.14	.47	......	1.018	.478	.488	60,739	23.7	49.0	6	R.
......	.13	.39	......	1.023	.420	.430	60,474	25.5	52.0	4	A.
......	.18	.23	......	1.003	.423	.426	60,040	25.5	47.0	4	A.
......	.22	.34	......	1.004	.516	.518	59,200	25.5	48.0	8	R.

TABLE V.—*Tensile tests, Norway steel*—Continued.

Heat number.	Carbon.	Manganese.	Phosphorus.	Average original width.	Average original thickness.	Average original area.	Average ultimate tensile strength per square inch.	Average final elongation.	Average final area.	Number of tests.	Accepted or rejected.
	Per ct.	*Per ct.*	*Per ct.*	*Inches.*	*Inches.*	*Sq. ins.*	*Pounds.*	*Per ct.*	*Per ct.*		
1974	.18	.33	......	1.000	.512	.512	58,900	27.0	49.0	6	R.
1975	.18	.31	......	.998	.510	.509	59,000	26.5	48.0	6	R.
1995	.14	.26	......	.987	.437	.445	60,340	26.0	42.0	4	A.
2009	.12	.33	......	.991	.434	.429	61,625	25.5	51.0	4	A.
2013	.15	.23	......	.998	.450	.449	59,200	26.0	50.0	6	R.
2051	.12	.44	......	.990	.415	.414	60,964	26.0	51.0	4	A.
2053	.12	.35	......	.993	.406	.404	57,288	24.0	50.0	6	R.
2055	.16	.42	......	.999	.490	.490	55,850	26.0	43.0	4	R.
2057	.16	.36	......	.966	.463	.448	60,516	26.0	43.0	4	A.
2059	.12	.35	......	.987	.480	.474	60,450	26.0	39.0	4	A.
2063	.12	.33	......	.986	.462	.455	60,850	26.3	47.0	4	A.
2064	.16	.48	......	.986	.401	.398	61,020	25.3	51.0	4	A.
2066	.16	.43	......	.987	.405	.399	62,393	26.0	54.0	4	A.
2070	.13	.45	......	.991	.465	.461	61,430	29.0	47.0	4	A.
2088	.15	.23	......	.995	.458	.456	60,344	26.3	43.0	4	A.
2091	.16	.40	......	1.001	.465	.465	63,685	26.0	46.0	4	A.
2095	.16	.53	......	1.000	.470	.470	63,049	26.0	51.0	4	A.
2097	.18	.36	......	.998	.452	.451	64,450	26.0	51.0	4	A.
2099	.16	.36	......	.991	.423	.419	63,251	26.0	50.0	4	A.
2109	.16	.40	......	.991	.461	.456	66,721	26.0	49.0	4	A.
2111	.12	.46	......	.990	.464	.458	62,844	27.5	53.0	4	A.
2113	.18	.50	......	1.920	.290	.555	65,791	26.0	60.0	4	A.
2115	.13	.32	......	.983	.466	.460	60,500	26.5	49.0	4	A.
2117	.15	.33	......	.990	.466	.461	60,610	27.0	46.0	4	A.
2119	.14	.33	......	1.920	.290	.557	65,584	29.0	52.0	4	A.
2136	.13	.35	......	1.225	.290	.355	63,080	25.2	59.0	4	A.
2138	.18	.45	......	.984	.420	.417	69,556	25.5	58.0	4	A.
2139	.15	.40	......	1.222	.296	.361	63,823	26.3	44.0	4	A.
2140	.17	.37	......	1.222	.287	.351	63,092	27.5	54.0	4	A.
2141	.14	.45	......	.990	.427	.422	65,198	25.2	51.0	4	A.
2143	.14	.29	......	.986	.424	.420	60,197	25.5	55.0	4	A.
2145	.13	.33	......	.988	.435	.429	62,544	26.0	45.0	4	A.
2149	.17	.42	......	.986	.440	.433	64,908	25.0	46.0	4	A.
2151	.15	.31	......	.988	.431	.419	61,435	27.0	40.0	4	A.
2153	.21	.28	......	.966	.442	.433	71,690	21.3	46.0	6	R.
2156	.12	.39	......	.993	.426	.424	60,862	25.5	44.0	4	A.
2160	.13	.39	......	.985	.443	.436	61,530	28.0	49.0	4	A.
2162	.16	.42	......	.984	.438	.432	60,688	26.2	48.0	4	A.
2163	.15	.37	......	.985	.443	.439	61,300	25.5	50.0	4	A.
2164	.16	.38	......	.983	.441	.434	62,180	27.5	52.0	4	A.
2165	.15	.48	......	.983	.430	.420	63,560	23.0	49.0	6	R.
2167	.14	.42	......	.980	.430	.421	60,615	26.0	50.0	4	A.
2168	.13	.39	......	.979	.415	.406	61,520	25.5	48.0	4	A.
2171	.16	.33	......	.978	.463	.450	60,590	25.5	46.0	4	A.
2173	.15	.35	......	.982	.442	.434	62,220	26.3	44.0	4	A.
2175	.17	.42	......	.989	.423	.418	61,497	26.0	56.0	4	A.
2176	.18	.39	......	.979	.431	.421	63,050	25.5	43.0	4	A.
2177	.12	.33	......	.977	.442	.414	56,745	30.0	40.0	6	R.
2178	.17	.33	......	.988	.418	.413	63,270	23.0	50.0	6	R.
2180	.15	.31	......	.991	.412	.410	59,862	25.0	52.0	4	R.
2181	.14	.44	......	.989	.413	.409	58,996	27.0	53.0	8	R.
2182	.14	.31	......	.988	.425	.420	57,562	25.5	43.0	6	R.
2187	.14	.35	......	.988	.427	.418	61,091	26.5	40.0	4	A.
2188	.13	.28	......	.992	.419	.415	58,800	26.0	49.0	6	R.
2189	.15	.36	......	.992	.421	.418	59,100	25.5	50.0	4	R.
2190	.14	.31	......	.990	.420	.416	60,752	26.5	50.0	4	A.
2191	.15	.32	......	.985	.430	.427	63,967	25.2	50.0	4	A.
2192	.13	.28	......	.990	.417	.414	63,694	27.0	43.0	4	A.
2195	.15	.36	......	.990	.420	.416	60,190	27.5	37.0	4	A.
2196	.20	.39	......	.986	.423	.418	60,938	26.5	41.0	4	A.
2197	.16	.30	......	.987	.420	.413	61,031	25.5	41.0	4	A.
2198	.12	.32	......	.986	.426	.420	61,304	25.5	43.0	4	A.
2199	.19	.39	......	.982	.419	.410	64,070	27.5	47.0	4	A.
2200	.23	.28	......	.978	.407	.398	65,190	25.0	51.0	4	A.
2201	.19	.35	......	.990	.416	.413	63,271	25.0	45.0	4	A.
2202	.12	.33	......	.990	.423	.418	61,417	25.0	44.0	4	A.
2204	.14	.31	......	.979	.414	.403	64,127	25.0	48.0	4	A.
2205	.18	.34	......	.984	.418	.411	62,246	25.0	48.0	4	A.
2206	.15	.31	......	.989	.405	.403	61,267	25.5	49.0	4	A.
2208	.12	.24	......	.982	.419	.411	60,142	[illegible]	30.0	4	A.
2213	.12	.44	......	.985	.408	.404	60,815	[illegible]	45.0	4	A.
2215	.12	.30	......	.986	.423	.417	60,565	[illegible]	40.0	4	A.

TABLE V.—*Tensile tests, Norway steel*—Continued.

umber.	Carbon.	Manganese.	Phosphorus.	Average original width.	Average original thickness.	Average original area.	Average ultimate tensile strength per square inch.	Average final elongation.	Average final area.	Number of tests.	Accepted or rejected.
	Per ct.	*Per ct.*	*Per ct.*	*Inches.*	*Inches.*	*Sq. ins.*	*Pounds.*	*Per ct.*	*Per ct.*		
....	.14	.29	......	.982	.471	.463	60,524	26.0	41.0	4	A.
....	.18	.29	......	.985	.424	.418	62,872	25.5	54.0	4	A.
....	.15	.39	......	.984	.404	.397	63,081	25.2	50.0	4	A.
....	.14	.24	......	.967	.466	.454	60,265	28.2	50.0	4	A.
....	.15	.39	......	.965	.422	.409	61,141	25.5	45.0	4	A.
....	.15	.45	......	.985	.424	.419	65,796	26.0	45.0	4	A.
....	.15	.27	......	.984	.470	.463	63,169	25.0	51.0	4	A.
....	.14	.23	......	.987	.462	.456	63,078	26.0	53.0	4	A.
....	.17	.33	......	.986	.464	.457	61,886	26.5	43.0	4	A.
....	.16	.32	......	.981	.471	.463	62,050	26.0	42.0	4	A.
....	.16	.30	......	.980	.430	.423	62,382	26.0	42.0	4	A.
....	.14	.30	......	.979	.417	.412	61,939	26.0	49.0	4	A.
....	.12	.30	......	.985	.422	.416	61,666	26.0	47.0	4	A.
....	.15	.21	......	1.220	.244	.299	62,492	25.0	49.0	4	A.
....	.15	.33	......	1.260	.255	.320	65,273	25.0	54.0	4	A.
....	.15	.36	......	1.260	.245	.307	69,287	26.0	56.0	4	A.
....	.19	.36	......	1.230	.253	.311	66,369	25.0	52.0	4	A.
....	.17	.40	......	1.220	.240	.294	65,058	25.0	50.0	4	A.
....	.19	.32	......	1.235	.249	.308	65,059	25.0	51.0	4	A.
....	.18	.31	......	1.220	.242	.295	65,090	25.0	53.0	4	A.
....	.16	.38	......	1.220	.230	.281	63,681	27.0	46.0	4	A.
....	.19	.35	......	1.220	.239	.293	67,231	25.0	48.0	4	A.
....	.18	.33	......	1.220	.245	.299	67,146	25.0	46.0	4	A.
....	.15	.29	......	1.222	.249	.308	63,794	26.0	46.0	4	A.
....	.13	.33	......	1.210	.238	.287	66,260	26.0	47.0	4	A.
....	.15	.31	......	1.210	.243	.295	65,998	25.0	47.0	4	A.
....	.12	.30	......	1.222	.241	.296	64,138	25.0	46.0	4	A.
....	.14	.26	......	1.220	.245	.297	64,968	25.0	47.0	4	A.
....	.14	.36	......	.987	.240	.237	66,404	25.0	50.0	4	A.
....	.13	.31	......	.985	.475	.468	60,910	25.0	49.0	4	A.
....	.15	.38	......	.983	.477	.469	62,330	25.0	43.0	4	A.
....	.21	.41	......	.987	.473	.467	69,286	25.0	54.0	4	A.
....	.16	.28	......	.980	.457	.449	67,682	25.0	53.0	4	A.
....	.13	.36	......	.984	.460	.453	59,597	27.0	47.0	6	R.
....	.18	.35	......	.983	.469	.461	62,424	25.0	48.0	4	A.
....	.15	.32	......	.984	.457	.450	63,966	25.3	48.0	4	A.
....	.13	.36	......	.983	.470	.462	60,677	25.0	53.0	4	A.
....	.12	.27	......	.980	.460	.451	61,793	25.0	46.0	4	A.
....	.18	.31	......	.982	.460	.452	60,712	26.0	47.0	4	A.
....	.17	.31	......	.985	.490	.480	63,142	25.3	47.0	4	A.
....	.18	.34	......	.981	.463	.454	63,486	25.5	47.0	4	A.
....	.13	.33	......	.985	.458	.451	61,287	25.0	46.0	4	A.
....	.15	.31	......	.987	.482	.476	61,585	26.0	49.0	4	A.
....	.14	.27	......	.987	.306	.304	61,257	25.0	64.0	4	A.
....	.18	.49	......	.982	.450	.441	64,820	25.5	45.0	4	A.
....	.22	.36	......	.984	.473	.465	61,102	25.0	49.0	4	A.
....	.15	.31	......	.981	.476	.466	61,358	26.5	49.0	4	A.
....	.18	.33	......	.976	.455	.444	60,231	25.5	49.0	4	A.
....	.17	.36	......	.979	.473	.463	62,485	25.5	47.0	4	A.
....	.12	.38	......	.981	.477	.467	63,104	26.0	51.0	4	A.
....	.13	.43	......	.977	.460	.450	61,957	25.5	53.0	4	A.
....	.12	.35	......	.977	.467	.456	62,827	25.0	52.0	4	A.
....	.18	.43	......	.975	.475	.463	61,865	25.0	51.0	4	A.
....	.15	.38	......	.984	.421	.414	60,600	25.0	41.0	4	A.
....	.18	.40	......	.986	.422	.417	64,825	24.0	41.0	6	R.
....	.14	.33	......	.983	.421	.412	63,030	25.0	42.0	4	A.
....	.15	.32	......	.976	.463	.453	61,944	25.5	41.0	8	A.
....	.12	.46	......	.982	.426	.419	59,890	26.0	41.0	8	R.
....	.13	.36	......	.985	.422	.417	60,849	26.0	42.0	4	A.
....	.18	.35	......	.982	.412	.405	64,759	25.0	43.0	4	A.
....	.18	.36	......	.983	.421	.413	61,930	26.3	45.0	4	A.
....	.15	.30	......	.971	.469	.456	61,624	25.2	52.0	4	A.
....	.18	.30	......	.976	.478	.466	62,821	25.2	53.0	4	A.
....	.12	.35	......	.976	.490	.477	61,381	25.0	52.0	4	A.
....	.12	.36	......	.981	.455	.444	58,000	22.5	39.0	6	R.
....	.15	.35	......	.971	.300	.290	64,294	25.3	49.0	4	A.
....	.18	.25	......	.976	.300	.294	63,207	25.2	53.0	4	A.
....	.13	.30	......	.977	.476	.465	57,920	20.5	49.0	6	R.
....	.13	.28	......	.970	.236	.229	62,158	25.0	53.0	4	A.
....	.14	.27	......	.968	.244	.236	60,357	25.0	52.0	4	A.
....	.13	.27	......	.989	.281	.279	60,837	25.0	53.0	4	A.
....	.13	.36	......	.990	.245	.243	66,936	25.0	61.0	4	A.
....	.14	.39	......	.979	.418	.409	58,180	20.5	48.0	6	R.
....	.15	.34	......	.984	.241	.237	62,713	25.2	56.0	4	A.

TABLE V.—*Tensile tests, Norway steel*—Continued.

Heat number.	Carbon.	Maganese.	Phosphorus.	Average original width.	Average original thickness.	Average original area.	Average ultimate tensile strength per square inch.	Average final elongation.	Average final area.	Number of tests.	[illegible]
	Per ct.	*Per ct.*	*Per ct.*	*Inches.*	*Inches.*	*Sq. ins.*	*Pounds.*	*Per ct.*	*Per ct.*		
2368	.14	.25	......	.976	.296	.290	61,177	26.0	52.0	4	
2369	.18	.30	......	.982	.446	.438	57,999	21.0	44.0	5	
2371	.14	.25	......	.976	.447	.241	64,354	25.0	61.0	4	
2373	.17	.40	......	.984	.418	.412	58,006	21.2	46.0	5	
2375	.15	.27	......	.984	.482	.473	61,500	25.3	47.0	4	
2377	.15	.31	......	.977	.300	.293	62,498	25.2	50.0	4	
2379	.19	.35	......	.975	.300	.293	65,713	26.0	51.0	4	
2381	.18	.35	......	.986	.291	.287	66,368	25.5	53.0	4	
2382	.18	.30	......	.983	.275	.271	64,107	25.0	52.0	4	
2384	.18	.45	......	.989	.297	.295	65,026	25.2	53.0	4	
2386	.17	.46	......	.981	.295	.290	65,298	25.2	54.0	4	
2387	.15	.31	......	.984	.299	.295	63,739	26.3	50.0	4	
2388	.27	.29	....	.974	.299	.292	61,545	26.0	49.0	4	
2390	.15	.30	....	.984	.472	.464	61,000	26.0	55.0	4	
2391	.18	.33	......	.980	.473	.464	61,207	25.2	55.0	4	
2393	.18	.37	......	.983	.472	.463	66,047	25.0	58.0	4	
2394	.16	.37	......	.978	.482	.471	65,142	26.0	52.0	4	
2395	.18	.30	......	.982	.472	.461	60,623	26.0	52.0	4	
2396	.19	.30	......	.982	.473	.465	63,705	25.2	52.0	4	
2397	.18	.28	......	.985	.248	.242	63,546	25.3	51.0	4	
2398	.12	.31	......	.974	.241	.235	64,166	25.3	58.0	4	
2401	.20	.30	......	.975	.247	.242	64,039	25.5	55.0	4	
2402	.31	.39	....	.979	.237	.232	72,754	25.0	62.0	4	
2403	.17	.35	......	.972	.238	.231	70,096	26.0	62.0	4	
2404	.16	.33	......	.982	.470	.462	67,057	21.5	51.0	6	
2405	.22	.36	....	.974	.236	.228	64,456	25.5	54.0	4	
2406	.23	.23	......	.975	.227	.221	69,155	25.0	61.0	4	
2407	.14	.34	......	.974	.237	.231	66,350	25.0	56.0	4	
2408	.21	.32	......	.988	.300	.297	65,843	25.0	46.0	4	
2409	.18	.30	......	.984	.282	.277	63,250	25.3	52.0	4	
2410	.18	.31	......	.982	.300	.295	63,382	25.0	47.0	4	
2411	.19	.35	......	.989	294	.293	63,630	26.2	50.0	4	
39	.13	.32	......	.970	.300	.290	60,080	27.0	50.0	4	
40	.18	.33	......	.970	.303	.294	62,280	25.2	53.0	4	
41	.17	.18	......	.969	.291	.281	60,190	26.0	54.0	4	
43	.22	.30	....	.968	.299	.290	62,170	25.3	52.0	4	
44	.22	.20	....	.970	304	.295	64,709	24.0	51.0	4	
45	.17	.23	......	.976	.287	.280	60,694	26.5	52.0	4	
62	.18	.32	......	.978	.298	.293	65,781	23.0	53.0	4	
64	.16	.38	......	.980	.311	.305	61,303	26.5	46.0	4	
65	.16	.31	......	.983	.280	.280	60,845	28.2	52.0	4	
66	.18	.33	......	.990	.299	.299	60,552	27.0	49.0	4	
67	.15	.26	......	.980	.305	.299	60,291	26.2	46.0	4	
68	.14	.38	....	.979	.301	.294	58,462	28.0	48.0	6	
69	.18	.37	......	.980	.283	.280	61,230	21.0	54.0	[illegible]	
70	.16	.40	....	.978	.312	.305	60,270	27.0	49.0	4	
71	.20	.25	......	.980	.296	.290	61,750	24.5	50.0	4	
72	.19	.35	......	.978	.303	.297	62,934	24.0	49.0	4	
73	.20	.27	......	.979	.293	.290	61,285	25.0	49.0	4	
99	.15	.32	......	.974	.298	.291	61,834	25.5	50.0	4	
100	.15	.32	......	.976	.284	.278	60,324	25.5	53.0	4	
107	.22	.38	......	.976	.301	.294	61,750	26.0	50.0	4	
110	.21	.45	......	.976	.293	.286	66,513	24.5	52.0	4	
111	.22	.17	......	.981	.303	.298	63,281	24.0	52.0	4	
112	.17	.46	......	.963	.281	.271	62,203	27.0	50.0	4	
113	.15	.15	......	.982	.297	.293	60,797	25.5	46.	4	
114	.18	.39	......	.979	.300	.294	62,174	25.5	48.	4	
115	.17	.36	......	.968	.277	.268	63,329	25.2	52.0	4	
116	.16	.34	....	.991	.306	.304	60,269	25.3	47.0	4	
117	.14	.39	....	.987	.275	.271	60,088	27.0	50.0	4	
118	.15	.39	....	.978	.285	.279	62,948	28.0	50.0	4	
119	.17	.23	......	.977	.308	.302	60,695	26.5	50.0	4	
120	.15	.27	......	.980	.287	.281	60,697	26.5	50.0	4	
176	.16	.46	....	.974	.290	.281	64,368	24.2	57.0	4	
178	.17	.43	......	.975	.308	.300	60,337	24.3	49.0	4	
180	.22	.47	......	.967	.296	.283	63,041	23.5	51.0	4	
181	.20	.47	......	.969	.292	.282	60,129	27.0	51.0	4	
182	.18	.46	....	.965	.289	.279	63,380	25.5	51.0	4	
184	.19	.43	......	.980	.290	.285	62,728	24.5	56.0	4	
186	.12	.31	....	.986	.330	.325	57,993	26.5	50.0	6	
187	.17	.29	......	.989	.310	.307	59,331	25.5	49.0	6	
188	.15	.43	......	.988	.338	.334	58,175	24.3	44.0	[illegible]	
189	.19	.45	......	.991	.330	.326	64,160	24.2	49.0	4	
190	.13	.35	......	.986	.333	.329	60,420	24.0	47.0	4	

TABLE V.—*Tensile tests, Norway steel*—Continued.

Number.	Carbon.	Manganese.	Phosphorus.	Average original width.	Average original thickness.	Average original area.	Average ultimate tensile strength per square inch.	Average final elongation.	Average final area.	Number of tests.	Accepted or rejected.
	Per ct.	Per ct.	Per ct.	Inches.	Inches.	Sq. ins.	Pounds.	Per ct.	Per ct.		
....	.19	.51	......	.973	.327	.318	63,945	24.5	49.0	4	A.
....	.19	.49	......	.971	.344	.333	62,418	26.0	48.0	4	A.
....	.14	.50	......	.971	.350	.340	56,994	25.3	44.0	6	R.
....	.19	.43	......	.967	.366	.354	62,841	26.0	59.0	4	A.
....	.13	.43	......	.964	.344	.336	60,269	26.0	48.0	4	A.
....	.12	.51	......	.977	.332	.324	62,456	24.0	55.0	4	A.
....	.13	.43	......	.976	.335	.327	62,543	21.5	52.0	4	R.
....	.16	.55	......	.978	.339	.332	60,168	27.0	48.0	4	A.
....	.18	.35	......	.978	.340	.329	60,222	26.0	48.0	4	A.
....	.17	.47	......	.978	.345	.337	61,625	27.0	48.0	4	A.
....	.19	.53	......	.961	.330	.317	63,013	25.0	47.0	4	A.
....	.13	.35	......	.956	.336	.321	62,318	24.3	48.0	4	A.
....	.19	.49	......	.960	.334	.321	61,423	24.3	45.0	4	A.
....	.17	.39	......	.964	.333	.320	60,500	24.5	46.0	4	A.
....	.19	.37	......	.978	.369	.361	63,347	25.0	48.0	4	A.
....	.21	.44	......	.980	.374	.367	64,219	26.0	58.0	4	A.
....	.16	.41	......	.974	.382	.371	60,511	25.3	51.0	4	A.
....	.17	.39	......	.973	.335	.325	65,699	25.3	46.0	4	A.
....	.14	.40	......	.963	.333	.321	60,875	30.0	46.0	4	A.
....	.15	.31	......	.974	.330	.321	61,450	27.0	46.0	4	A.
....	.15	.30	......	.971	.328	.319	64,563	26.5	47.0	4	A.
....	.18	.61	......	.968	.336	.323	66,819	26.2	48.0	4	A.
....	.20	.59	......	.976	.331	.323	71,702	22.3	49.0	6	R.
....	.21	.36	......	.987	.325	.324	62,436	26.0	47.0	4	A.
....	.19	.42	......	.989	.344	.340	62,575	25.3	44.0	4	A.
....	.17	.50	......	.987	.336	.332	64,860	22.2	48.0	8	R.
....	.18	.38	......	.977	.345	.337	59,980	27.0	46.0	4	A.
....	.14	.40	......	.977	.339	.331	60,475	28.0	47.0	4	A.
....	.20	.40	......	.977	.328	.320	60,990	27.0	48.0	4	A.
....	.19	.32	......	.993	.329	.327	59,379	26.0	47.0	6	R.
....	.17	.47	......	1.005	.331	.332	66,761	23.5	49.0	4	A.
....	.14	.52	......	1.001	.326	.326	61,350	26.0	48.0	4	A.
....	.13	.37	......	1.007	.321	.323	58,939	26.3	47.0	6	R.
....	.18	.39	......	1.006	.343	.344	61,279	25.0	45.0	4	A.
....	.18	.29	......	.997	.335	.334	60,597	26.0	45.0	4	A.
....	.15	.35	......	.996	.339	.338	61,946	25.5	46.0	4	A.
....	.15	.35	......	.999	.333	.333	62,152	24.5	47.0	4	A.
....	.19	.47	......	.977	.339	.331	64,403	24.5	46.0	4	A.
....	.18	.47	......	.977	.340	.331	61,882	27.0	44.0	4	A.
....	.17	.45	......	.980	.340	.333	63,222	25.3	48.0	4	A.
....	.19	.34	......	.980	.340	.333	62,846	25.0	45.0	4	A.
....	.14	.44	......	.980	.336	.369	59,608	26.3	47.0	8	R.
....	.16	.39	......	.978	.328	.320	60,544	25.5	47.0	4	A.
....	.13	.33	......	.980	.333	.327	61,811	25.0	45.3	4	A.
....	.19	.47	......	.991	.355	.350	65,727	24.0	45.0	4	A.
....	.21	.45	......	.982	.342	.336	65,152	26.5	47.5	4	A.
....	.27	.47	......	.976	.325	.319	70,532	24.0	49.0	4	A.
....	.18	.34	......	.983	.343	.337	58,311	28.3	45.5	6	R.
....	.19	.32	......	.985	.350	.345	62,839	23.0	45.0	6	R.
....	.17	.42	......	.978	.335	.327	60,617	24.5	47.5	4	A.
....	.15	.34	......	.983	.345	.341	60,387	24.3	45.5	4	A.
....	.13	.39	......	.982	.346	.340	60,740	23.5	45.0	4	A.
....	.14	.27	......	.984	.340	.335	65,660	21.3	57.0	6	R.
....	.18	.31	......	.981	.340	.334	64,142	23.5	57.0	4	A.
....	.15	.49	......	.985	.341	.336	63,027	25.0	46.0	4	A.
....	.18	.49	......	.976	.328	.320	60,097	27.0	46.0	4	A.
....	.19	.37	......	.750	.608	.457	58,822	27.0	47.0	4	A.*
....	.20	.37	......	.977	.323	.318	62,338	25.2	48.0	4	A.
....	.15	.22	......	.978	.336	.328	58,200	25.0	47.0	6	R.
....	.19	.43	......	.973	.348	.338	64,174	25.0	46.0	4	A.
....	.17	.53	......	.974	.343	.334	58,627	28.0	46.0	8	R.
....	.18	.43	......	.982	.346	.339	60,888	27.3	47.0	4	A.
....	.23	.39	......	.979	.347	.339	65,508	25.0	46.0	4	A.
....	.13	.30	......	.750	.593	.445	60,398	25.0	48.0	4	A.
....	.19	.45	......	.975	.338	.330	63,935	25.5	47.0	4	A.
....	.16	.55	......	.978	.345	.337	57,688	27.0	45.0	6	R.
....	.18	.40	......	.970	.348	.338	56,570	28.0	43.0	6	R.
....	.20	.37	......	.981	.358	.326	63,650	24.5	47.0	4	A.
....	.18	.39	......	.977	.323	.315	62,071	27.0	48.0	4	A.
....	.18	.57	......	.972	.345	.335	63,054	25.3	45.0	4	A.
....	.17	.26	......	.973	.338	.329	56,895	28.5	45.0	6	R.

* Boiler metal.

TABLE V.—*Tensile tests, Norway steel*—Continued.

Heat number.	Carbon.	Manganese.	Phosphorus.	Average original width.	Average original thickness.	Average original area.	Average ultimate tensile strength per square inch.	Average final elongation.	Average final area.	Number of tests.	Accepted or rejected.
	Per ct.	*Per ct.*	*Per ct.*	*Inches.*	*Inches.*	*Sq. ins.*	*Pounds.*	*Per ct.*	*Per ct.*		
446	.19	.39	......	.972	.332	.324	63,609	26.0	47.0	4	A
448	.23	.41	.....	.966	.348	.336	62,378	25.0	48.0	4	A
450	.19	.50	......	.970	.349	.339	62,150	26.5	44.0	6	A
452	.19	.45	......	.981	.383	.376	60,231	30.0	39.0	4	A
454	.14	.45	......	.979	.368	.360	61,951	25.0	43.0	4	A
455	.26	.40	......	.980	.380	.373	66,839	25.0	43.0	4	A
456	.18	.41	......	.976	.375	.366	65,471	20.3	64.0	6	R
457	.19	.41	.....	.978	.365	.357	65,762	23.5	57.0	4	A
458	.18	.37	......	.970	.359	.352	62,321	24.3	49.0	4	A
459	.19	.39	......	.976	.367	.357	59,707	27.0	43.0	4	A
460	.23	.56	......	.980	.382	.375	63,267	25.0	58.0	4	A
462	.21	.44	.....	.982	.395	.388	62,255	25.0	51.0	4	A
464	.18	.40	......	.986	.358	.354	60,056	27.0	44.0	4	A
466	.24	.44	......	.985	.350	.344	62,253	28.0	44.0	4	A
467	.19	.51	......	.983	.366	.352	60,658	26.3	44.0	4	A
468	.23	.43	......	.988	.336	.333	60,100	27.0	44.0	4	A
469	.22	.40	......	.983	.350	.344	61,555	25.2	44.0	4	A
470	.23	.48	......	.976	.373	.364	62,581	27.0	42.0	4	A
471	.18	.42	......	.978	.353	.345	60,550	25.0	43.0	4	A
472	.19	.46	......	.974	.374	.364	60,800	27.5	43.0	4	A
473	.22	.47	......	.991	.360	.357*	61,905	23.5	43.0	4	A
474	.18	.31	.....	.993	.340	.338	57,488	28.3	45.0	6	R
475	.17	.49	......	.997	.362	.361	53,492	27.0	42.0	4	R
476	.19	.50	.....	.995	.313	.313	64,280	24.0	50.0	4	A
478	.20	.60	.....	.992	.357	.354	65,208	25.3	45.0	4	A
483	.19	.47	......	.995	.360	.358	66,765	24.0	52.0	4	A
495	.16	.48	......	.995	.360	.358	60,045	27.0	42.0	4	A
496	.18	.52	......	.993	.361	.359	64,936	24.5	46.0	4	A
497	.20	.44	......	.994	.382	.381	61,859	27.0	40.0	4	A
498	.20	.39	......	.991	.366	.364	63,925	25.5	44.0	4	A
499	.21	.51	.....	.990	.367	.363	66,948	23.3	49.0	4	A
500	.22	.54	......	.994	.366	.363	72,666	23.2	45.0	4	A
501	.19	.50	......	.992	.379	.376	64,981	24.0	42.0	4	A
502	.21	.55	.....	.985	.364	.358	62,258	24.3	43.0	4	A
503	.20	.44	......	.986	.298	.294	69,432	17.0	52.0	6	R
505	.20	.51	......	.981	.337	.330	64,944	25.0	47.0	4	A
506	.20	.58	......	.983	.356	.350	63,401	26.5	45.0	4	A
507	.19	.64	......	.981	.337	.331	63,186	24.0	46.0	4	A
508	.18	.45	......	.988	.346	.342	62,008	25.0	46.0	4	A
509	.13	.46	......	.983	.313	.307	60,834	25.3	50.0	4	A
510	.18	.53	......	.982	.341	.335	60,800	26.0	45.0	4	A
511	.18	.49	......	.991	.364	.360	60,341	27.0	43.0	4	A
512	.19	.47	......	.987	.325	.322	61,709	25.0	48.0	4	A
515	.18	.45	......	.982	.342	.336	61,285	26.5	46.0	4	A
519	.19	.42	......	.975	.357	.348	63,481	26.0	44.0	4	A
520	.18	.50	......	.981	.347	.341	62,949	25.5	47.0	4	A
524	.18	.55	......	.975	.346	.338	65,857	25.0	47.0	4	A
526	.19	.39	......	.976	.330	.323	66,081	25.5	46.0	4	A
658	.17	.43	.....	.971	.420	.399	62,724	23.8	57.0	6	R
659	.18	.29	......	.973	.407	.396	60,193	28.7	52.0	4	A
660	.15	.36	.....	.975	.401	.392	60,552	25.0	51.0	4	A
661	.18	.39	.....	.977	.429	.419	61,781	25.2	50.0	4	A
662	.11	.41	......	.975	.400	.398	61.442	25.5	53.0	4	A
663	.18	.31	.....	.968	.428	.414	56,506	24.3	52.0	6	R
664	.11	.34	......	1.005	.400	.402	58,271	26.2	51.0	4	A
665	.15	.41	.....	1.060	.409	.433	56,448	27.5	50.0	6	R
666	.16	.30	......	.999	.418	.418	58,710	27.5	51.0	4	A
667	.11	.34	......	1.010	.397	.401	57,617	28.5	46.0	4	A
668	.17	.40	......	1.022	.395	.403	61,744	28.2	53.0	4	A
676	.16	.42	.....	.969	.418	.405	62,500	27.8	50.0	4	A
677	.14	.34	.....	.969	.394	.381	58,950	28.0	50.0	4	A
678	.12	.36	.....	.972	.390	.379	58,080	26.0	51.0	4	A
679	.12	.43	......	.970	.420	.407	56,834	25.5	50.0	6	R

* Rejected for boiler metal.

BLACK DIAMOND STEEL.—PARK, BRO. & CO.

(Inspectors, Passed Assistant Engineer E. A. Magee and Assistant Engineer L. D. Miner, U. S. N.)

The material to be supplied consisted entirely of ship-plate, and was produced by the Siemens-Martin process in two 14-ton furnaces. The erection of these furnaces was commenced August 18, 1879, by Messrs. William Swindell & Bros., of Pittsburgh, the first cast being made in 1880. They were subsequently enlarged to 12 tons capacity, and finally, in September, 1883, to 14 tons each. They stand side by side in one pit of 33 feet and 25 feet semi-diameters, and are served by a single ladle, of 15 tons capacity, operated by a hydraulic crane in the center of the pit. The furnaces are 29 feet 7 inches long by 10 feet 1½ inches wide by 10 feet 8½ inches high over all, while the hearth measures 13 feet 6 inches by 10 feet 10½ inches.

Coal-gas was supplied by Siemens producers until February 25, 1884, since which time natural gas, led 18 miles by pipe from Murraysville, Pa., has been used at a pressure of 1 pound to the square inch. It may be interesting to state that its composition varies as follows:

	Per cent.
Marsh gas (CH_4)	42 to 88
Hydrogen	10 to 39

with carbonic acid (CO_2), carbonic oxide (CO), olefiant gas (C_2H_4), and nitrogen in smaller and variable quantities. This gas is admitted cold at the ports of the furnace, the regenerators being used for the air only. It [illegible]not be preheated, on account of the carbon thrown down from the [illegible]n gas depositing itself in a hard layer on the checker-work, gradu[illegible]y clogging it. Nevertheless, it seems probable that the high propor[illegible] of hydrogen in the fuel ought, with proper management, to dimin[illegible]he amount of oxidation in the bath and give a better quality of [illegible]ct, by affording higher temperature with the same amount of air [illegible] when ordinary producer-gas is used. No trouble is experienced [illegible]variations in its composition, and its use gives general satisfaction and r[illegible]lts in a considerable saving in the cost of labor and fuel.

The c[illegible]ge for the mild steel supplied under the Board's inspection consisted of Ridgeway pig from Scotland, containing about 3⅛ per cent. of silicon and .03 per cent of phosphorus; charcoal-blooms from Chateaugay, Franklin County, New York, containing .015 to .03 per cent. of silicon and .008 to .02 per cent. of phosphorus, with traces of sulphur—these blooms form the bulk of the charge—; steel scrap from plates of this quality, ferro-manganese, generally from Terre-noire, France, and containing 70 to 85 per cent. of manganese and .2 to .3 per cent. of phosphorus. The materials were all charged cold.

Experimental heats were made, using puddled bars from Ridgeway pig. The resulting steel was very soft, giving only 59,000 pounds tensile strength, with .16 per cent. of carbon and .28 per cent. of manganese.

As illustrative of good practice it may be stated that, in addition to those mentioned above, the following materials are used for making other grades of steel than that supplied under this inspection:—Puddle bar; old molds made of Bessemer iron, so that when worn out they may be broken up and used in the steel furnace; spiegeleisen from Northern Germany or the Edgar Thomson Steel Works at Braddock, Pa., and containing 4 to 5 per cent. of carbon, 12 to 20 per cent. of manganese, .5 to 4 per cent. of silicon, .14 to .20 per cent. of phosphorus; red

hematite iron ore from the mines of the Republic Iron Ore Company, Northern Michigan, and containing 64 to 68 per cent. of iron, 2.86 per cent. (or less) of silica, and .03 to .04 per cent.of phosphorus.

It is believed that the proportion of scrap and bloom to pig is always large, so that, although decarburization is assisted by the use of ore in small quantity, the process remains more the "pig and scrap" than the "pig and ore."

The average weight of seventeen heats of metal made under this contract was 27,546 pounds; average time from charging to tapping seven hours, making about fifteen heats from each furnace weekly. Ferro-manganese was added to the bath before tapping.

The size and shape of ingot vary with the plate to be produced, the shape being an approximate parallelopiped, with a taper of one in 60 for stripping, and are different for top and bottom cast. For top cast the molds are 12 by 16 inches at the top and 60 inches high; for bottom cast, a set of molds giving ingots 7 inches thick and 50 inches high by widths varying by 2-inch increments from 18 to 36 inches; also 10 by 24 by 50 inches and 10 by 30 by 50 inches. For bottom cast eight molds are grouped together, with central runner, on a base plate 6 feet 8 inches in diameter.

The inspector reports that it is not thought to effect the quality of the steel whether top or bottom cast is used. Large plates are, however, bottom-poured, and are finished at one heat at the rolls. Lighter plates are top-cast, the ingots worked under the hammer into slabs 6 inches thick and of other dimensions to suit the size of plate, reheated and finished. The hammers used are a 17-ton and a 5½-ton, made by Messrs. Wm. Bement & Sons, Philadelphia, 40 and 26 inches diameter, and 9 and 5½ feet stroke, and strike a blow of 90 and 25 tons, respectively, using steam of 90 to 100 pounds pressure by gauge. With the larger hammer, it is said an average of 40 tons of ingots can be converted into slabs every twenty-four hours.

Two plate-mills are in use. The smaller is an 86 by 26 inch mill with three two-high housings, one cogging and two finishing. It can take an ingot 7 inches thick.

The larger mill is of new pattern and has only been in operation since June 28, 1884. It is a 115-inch three-high mill, with top and bottom rolls 32 inches in diameter and center roll 20 inches. It can take an ingot 15 inches thick and roll plates up to 112 inches width down to $\frac{3}{16}$ inch thick, and of length only controlled by the size of furnaces and facilities for handling, the weight of ingot being limited to 4,500 pounds.

The mill shears have 94-inch knives and can cut plates up to 1 inch thick.

The testing-machine used was a Riehlé hydraulic of 50,000 pounds capacity and similar in all respects to that described as in use at the Norway Steel and Iron Works, and illustrated by Fig. 6. It gave considerable trouble from leakage. Pieces for tensile test were straightened cold as left by the shears and cut out in a shaping-machine. They were measured for original width and thickness near each witness mark and in the middle, and a mean taken. Measurements for thickness of fractured area were made at one edge and in the center by sighting with a scale divided into hundredths of an inch, and the mean taken; and the width was similarly measured, the possible error in final area being perhaps as great as 2 per cent. of the original area.

The pieces for quenching test were inserted in a furnace, bent as they came from the shears, brought to the required temperature, removed

·aightened, and plunged into water. The furnace was generally with a smoky flame in contact with the pieces. After harden- ·y were bent in a form under a steam-hammer to an included of about 120°, then around another form to about 20°, and finally y under the hammer to the required curvature.

siderable trouble was experienced from this test, which may have from the pieces being heated for some time in contact with a flame, occasionally high in impurities, readily absorbed at the of the metal. The irregularities of edge produced by shears o often of such a kind, depending on the condition of the knives, make the piece peculiarly liable to tear from the sheared edges, there be any surface brittleness, fracture may be rapid with crys- surfaces. In such a case, as here, better results would be ob- if the edges were smoothed off with a fine file, as allowed, and ating done with a clear fire, the flame, if possible, being kept off ces.

exact amount of material rejected on this test cannot be obtained, as not convenient to weigh any plates but those to be shipped. hemical information accompanies the record of test.

total number of heats tested to September 1, 1884, was 65, of 9, or 13.8 per cent., were rejected on the tensile tests. Of the 56 ed heats the average tensile strength was 63,125 pounds per inch, with a corresponding average ductility of 25.83 per cent. in s. Of the material so accepted 287.4 tons were delivered at the ard up to September 1, 1884, while about 24 tons,* or 8.35 per cent., amount delivered failed on the quenching test.

following table gives the result of tensile tests in the order of

TABLE VI.—*Tensile tests, Black Diamond steel.*

umber	Carbon	Manganese	Phosphorus	Average original width	Average original thickness	Average original area	Average ultimate tensile strength per square inch	Average final elongation	Average final area	Number of tests	Accepted or rejected
	Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Inches*	*Inches*	*Sq. inch*	*Pounds.*	*Per ct.*	*Per ct.*		
				[illegible]	297	371	66,330	26.70	45.8	4	A
				[illegible]	[illegible]	593	[illegible],815	24.37	50.0	4	A
				[illegible]	[illegible]	[illegible]	61,210	23.90	48.5	4	A.
				[illegible]	611	[illegible]	[illegible],177	23.60	50.0	4	A
				[illegible]	280	355	63,705	25.20	49.0	4	A
				[illegible]	[illegible]	517	[illegible],587	21.50	48.7	4	A
				[illegible]	[illegible]	[illegible]	66,072	23.[illegible]	50.7	4	A
				[illegible]	411	508	61,665	24.80	48.3	4	A
				[illegible]	[illegible]	507	66,600	25.00	50.0	4	A
				[illegible]	[illegible]	[illegible]	61,732	24.15	50.3	4	A
				[illegible]	204	305	72,485	24.60	50.0	4	A.
				[illegible]	467	[illegible]	67,907	25.40	52.5	4	A
				[illegible]	411	501	64,460	26.20	48.0	4	A
				[illegible]	412	507	64,582	25.00	48.0	4	A.
				[illegible]	[illegible]	[illegible]	62,459	25.90	45.8	4	A
				[illegible]	[illegible]	308	68,740	24.70	45.8	4	A
				[illegible]	[illegible]	[illegible]	60,642	26.31	[illegible]	4	A
				[illegible]	[illegible]	444	68,270	27.60	42.5	4	A
				[illegible]	231	201	66,805	24.74	47.2	4	A.
				[illegible]	348	442	62,075	24.15	47.9	4	A
				[illegible]	462	564	62,105	26.00	52.3	4	A
				[illegible]	463	573	61,015	27.30	44.0	4	A.
				[illegible]	350	442	65,772	20.78	30.5	4	R.

amount is not accurate, being obtained from the proportionate number of hich failed, the individual weight of such plates not being reported.

TABLE VI.—*Tensile tests, Black Diamond steel.*

Heat number.	Carbon	Manganese	Phosphorus.	Average original width.	Average original thickness.	Average original area.	Average ultimate tensile strength per square inch.	Average final elongation.	Average final area.	Number of tests	Accepted or rejected.
	Pr ct.	*Pr. ct.*	*Pr ct*	*Inches.*	*Inches.*	*Sq inch.*	*Pounds.*	*Per ct.*	*Per ct.*		
608				1.263	.462	.583	64,435	24.90	48.8	4	A.
610				1.235	.435	.537	64,430	26.52	47.4	4	*A
612				1.265	.414	523	69,115	23.06	53.0	4	A.
616				1.233	.474	.584	59,460	28.40	45.1	4	R.
638				1.268	.425	.538	64,537	26.03	48.9	4	A
640				1.257	.480	.603	64,740	26.91	47.8	4	A
642				1.254	.470	596	63,227	26.28	47.0	4	A.
651				1.257	.359	.451	61,546	22.21	43.0	4	R.
694				1.251	.484	.605	62,290	25.62	51.0	4	A.
696				1.254	.417	522	62,665	27.21	47.0	4	A.
703				1.249	.474	.592	63,252	23.77	47.9	4	A.
712				1.250	.361	.454	62,755	25.99	46.0	4	A
716				1.014	.517	.524	60,963	23.78	43.0	4	†R.
719				1.271	.504	.640	62,997	26.75	45.8	4	A
721				1.243	.492	.611	63,062	26.66	52.5	4	A
728				1.000	.541	.541	62,200	26.25	44.0	4	A.
745				1.017	.577	.586	61,840	25.62	48.0	4	A.
794				1.012	.529	.535	59,575	27.78	45.0	4	A.
801				1.228	.467	.572	60,550	28.93	45.0	4	A.
806				.970	517	.501	63,795	28.30	43.0	4	A.
814				.998	.516	.514	59,445	24.84	46.5	4	A.
837				1.016	.529	.537	61,900	23.30	47.0	4	‡R.
841				1.026	.525	.540	60,640	27.29	45.9	4	A.
843				1.006	532	.536	59,990	28.40	42.9	8	A.
862				1.005	.578	581	56,947	29.23	43.2	4	R.
881				1.011	.582	.589	62,692	25.65	47.1	4	A
888				1.227	287	.351	64,402	22.39	46.4	4	R.
891				1.008	542	546	62,697	26.57	48.7	4	A.
922				1.258	.282	353	62,955	27.02	47.0	4	A.
923				1.253	.328	.411	61,575	28.96	44.3	4	A.
924				.979	.693	679	60,396	26.93	43.6	4	A.
925				1.224	.240	291	66,325	23.64	46.3	4	A.
926				1.224	282	.337	66,820	25.97	46.6	4	A.
929				.993	679	.674	59,835	27.24	42.7	4	A
930				1.225	467	.572	58,076	29.80	39.9	4	R.
937				1.227	.239	.293	65,002	26.65	46.9	4	A.
942				1.254	226	.284	62,063	24.15	43.6	4	A.
951				1.243	281	351	63,932	25.67	46.8	4	A
954				1.243	470	585	60,742	27.22	45.8	4	A
1003				1.260	.369	.466	61,840	28.19	44.0	4	A
1004				1.262	.290	369	63,655	24.64	47.1	4	A.

* Annealed.
† One piece gave 20 per cent. elongation.
‡ One piece gave 14 per cent. elongation.

SUMMARY

Number of heats.	Material.	Average original area.	Average ultimate tensile strength per square inch.	Average final elongation.	Average final area.	Number of tests.
		Sq. in.	*Pounds.*	*Per ct.*	*Per ct.*	
56	Accepted	.4996	62.125	25.83	47.16	[illegible]
5	Rejected for lack of ductility	4611	62.896	22.61	46.00	
3	Rejected for lack of tensile strength	.5789	58.812	29.16	43.10	
1	Rejected for lack of tensile strength and ductility	.3530	58.222	20.84	42.50	

CAMBRIA STEEL.

ors, Assistant Naval Constructor R. Gatewood and Assistant Engineer B. C. Bryan, U. S. N.)

contract for all the angles, tees, and deck beams (to which flat r edge strips were afterwards added), in amount between one o thousand tons, required under this inspection, was given by p-building contractor to the Phœnix Iron Company of Phila-, with works at Phœnixville, Pa. Subcontract was entered into company with the Cambria Iron Company, Works at Johns-Pa., for the desired amount of material in blooms of required elivered at Phœnixville, and of such quality as to satisfy the company that the finished material would meet the requirements. ingly, nineteen heats, from 4121 to 4286, inclusive, were first by the Phœnix Iron Company's inspector, samples being taken flat bar $2\frac{1}{4}$ inches by $\frac{5}{8}$ inch, for tensile strength and ductility, hardening qualities by the quenching test. The results of these re given in the table, p. 434, in comparison with the tests subse- made on the finished material of the same heats. All heats sub-t to 4286, and including No. 4285, were tested at the Cambria Iron eel Works, under the Board's instructions of October 8 (pp. 399 0), the Government inspector accepting or rejecting heats to the x Iron Company's inspector, under the tensile tests, and the lat-er making a preliminary quenching test, notifying the Cambria ompany of the final acceptance or rejection of each heat. The ree heats so tested, 4285, 4301, and 4309, being intended partly for leck beams, the test pieces were taken from plates 12 inches wide ch thick. For convenience, a flat 6 inches by $\frac{7}{16}$ inch was after-taken for test in all cases (with a few accidental exceptions of flats of the same width), as representing the average amount k on the shapes required, the harder heats being preferably into blooms for deck beams, which have less work of reduction e test piece.

steel was made by the Siemens, or "pig, scrap, and ore," process— in some of the heats little or no scrap was used—in two fifteen-rnot revolving furnaces, with 16 foot pans, erected in 1878-'79. furnaces, with a twelve-ton furnace with $14\frac{1}{2}$ foot pan, now used dephosphorizing pig iron by the Krupp washer process, stand in der one roof, and with charging platform at the same level on the e side from the pit, and so high that the tops of the regenera hich are directly beneath the bearing platform, are four or five ove the floor level. To each of the larger furnaces there is a te circular pit sunk 5 feet below the floor level and supplied by ndent hydraulic cranes, while a 25 ton Sellers steam crane serves eral purposes, and especially in connection with the washer fur-d its pig bed. Heating furnaces at the rear of the charging m serve to preheat the pig for the charge. The scrap is charged Gas is supplied by four Siemens producers to each furnace. A lic lift supplies material for the charge and for the cupolas con- with the washing furnace.

composition of the charges varied widely, except for heats 5216, 5220, 5221, 5253, and 5255, which consisted entirely of washed and hematite ore, and are comparatively low in phosphorus

(below .05 per cent.). There is nothing noteworthy in their tensile tests except an appreciable fall of the elastic limit.

An average of five ingots of 5,500 pounds each was obtained from each heat. The time from charging to tapping was eight hours.

Ferro-manganese was added before tapping, and the bath was then rabbled while the hearth revolved, insuring perfect homogeneity in this respect.

The ingots were all top cast and of uniform pattern, being 14 inches square at the top and 18½ inches at the bottom, with corner fillets, and weighing 5,500 pounds each. One ingot of each heat was rolled down in the blooming mill as soon as possible after stripping, and two test billets removed, hammered down to slabs about 3 inches thick, reheated, and rolled down to 6-inch by $\frac{7}{16}$-inch flats. The remaining ingots were allowed to cool off completely while awaiting the results of the tests, which being reported satisfactory, they were charged in gas furnaces, of which eight, with an aggregate capacity for sixty-four ingots, are worked in connection with the blooming mill.

The blooming train is two high, with collared rolls 40 inches in diameter, and is driven by a reversing engine with two cylinders 40 inches in diameter and 48 inches stroke, working at 90 revolutions, and geared to the roll train 3 to 1. Half the weight of the upper roll is supported by steelyards in the pit, and its height is controlled by screws worked by hydraulic cylinders, one on each housing, thus allowing several passes through each groove. Hydraulic jaws turn the ingot on the table on each side and direct it to the proper groove.

This mill blooms down to 7 by 7 inches, supplying, of course, numerous intermediate sizes. Blooms, of whatever final size, are cut to weight here by hydraulic shears, with due allowance for subsequent heating and rolling. A 2½-ton steam-hammer, used for hot chipping, stands opposite to the shears.

The foundations for a new 48 inch blooming mill are complete, but its erection will probably not be proceeded with until the decision of Congress with regard to the establishment of a gun foundry, when certain alterations in the mill would render it useful in the manufacture of gun material, and especially of armor plate. Twelve Gjers soaking pits, which keep the ingot at a high temperature by its own heat in cooling in a non-conducting chamber, are placed back of the blooming mill, and have been used intermittently with little success, being too far from the Bessemer house to allow that certainty in handling necessary for working the pits alone without holding the furnaces in reserve for accident.

With the exception of blooms for 7, 8, and 9 inch deck beams, and 5 by 4 inch and 6 by 3½ inch angles, all blooms, after coming from the blooming mill, were reheated and rolled down in a 21-inch three-high mill, to the sizes as under:

Finished shape.	Corresponding size of bloom.
2 by 2 inch angles and under	3 by 3 inches.
2½ by 2½ inches	5 by 3 inches and 6½ by 5 inches.
2½ by 2½ inches to 5 by 4 inches	6½ by 5 inches.
5 by 4 inches and 6 by 3½ inches	8 by 4 inches (hammered).
6-inch deck beams	6½ by 5 inches.
7, 8, and 9 inch deck beams	7½ by 7 inches.

The blooms were shipped under the inspection of the Phœnix Iron Company's inspector, and while the larger flaws had been chipped under

hammer from the hot 7 by 7 bloom at the blooming mill, flaws in cold blooms were chipped when considered necessary down to the l metal.

t the Phœnix Iron Works angles of 2½ by 2½ inches and larger, and es and deck beams were rolled on a 20-inch three-high train, driven Corliss vertical tandem compound engine using steam of from 60 pounds pressure. For the deck beams a train of three sets was roughers, intermediates, and finishers, and the rolls were 22 inches center to center, while stronger connections were fitted. The other es were rolled in two sets of rolls. This mill is served by four Sie- gas furnaces with aggregate capacity of 48 blooms of ordinary

gles smaller than 2½ by 2½ inches were rolled on a 13-inch three- mill driven by a Corliss engine of design similar to that of the r mill. It is served by two smaller gas furnaces.

th Wilson's and Siemens' producers are used at these works, pref- y the former, and fine "buckwheat" anthracite coal has for some been successfully used.

its were rolled on a 10-inch two-high mill, the metal being heated naces using solid fuel.

this was the first steel rolled at these mills, considerable trouble experienced at first from overheating the material, but very soon n exhibited a preference to rolling steel over iron, on account of reater amount which can be turned out in the same time.

e capacity of the 20-inch mill with strengthened connections being equal to the manufacture of the 8 and 9 inch deck beams required, nch mill is now in course of erection with capacity for the largest beams, and probably 15-inch I-beams. When it is considered that inch mill is considered necessary to roll a T-rail 4½ inches high a 4-inch flange, it appears quite a feat in the art of rolling to have 9-inch deck beams over 50 feet long at one heat on a mill 3 inches ler.

ting at Johnstown.—Producing many grades of steel, from wire-stock boiler and bridge metal through the grades for rails and the parts of ultural implements up to the higher spring steels, the Cambria Iron pany has for some time been systematically testing each heat and The testing laboratory is correspondingly well equipped, and the t of physical tests of steel supplied is complete, and, as latterly , gives as much information from a single test as can well be obtained e limited time. The laboratory is supplied with two testing-ma- s, a large horizontal Riehlé of old pattern with a capacity of 150,000 ds, worked by hand, and used chiefly for grading the Bessemer , and a Gill machine of 100,000 pounds capacity, worked by belt and ng from a small vertical boiler and engine in the testing-room, and for testing wire-stock (Bessemer and open-hearth), boiler, ship, and e material, spring steels, and the open hearth product generally. is machine (see Fig. 7), the motion of the lower cross-head or e-block is given by a vertical screw of large diameter and fine , moving in a nut turned by gearing from a shaft within the frame- . This shaft revolves either by gearing from a hand-wheel for l motions, or through paper-faced friction-cones by belt and gear- rom the engine. The load upon the test piece is transferred by the r wedge-block to a lever at the top of the machine, and thence, igh the lower lever shown in the cut, to the beam-arm. The load d by a system of weights hanging by a stirrup from the end of m, and giving increments of 10,000 pounds for each weight

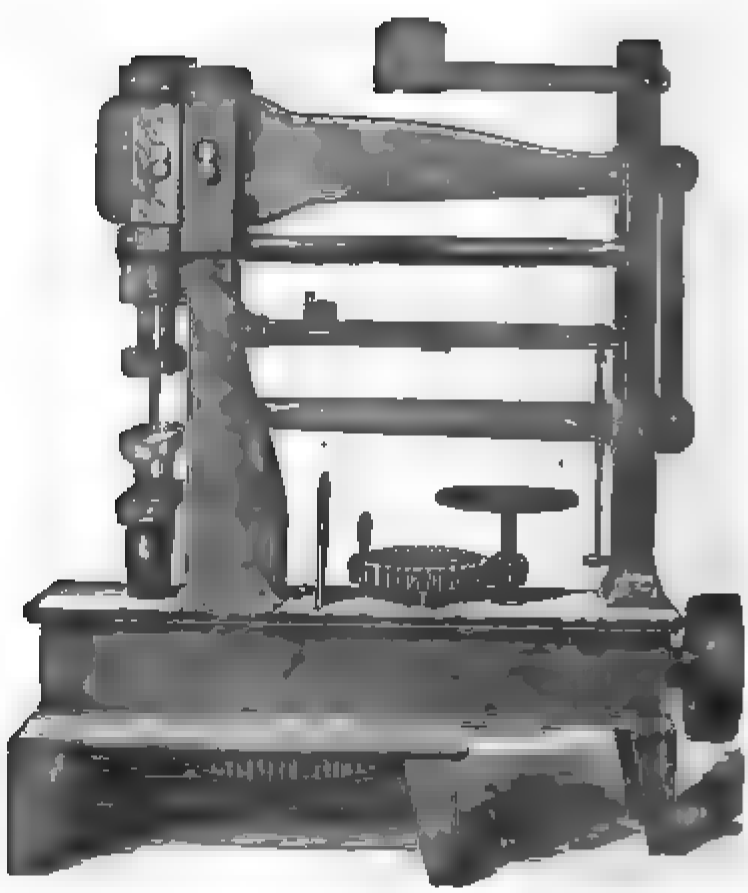
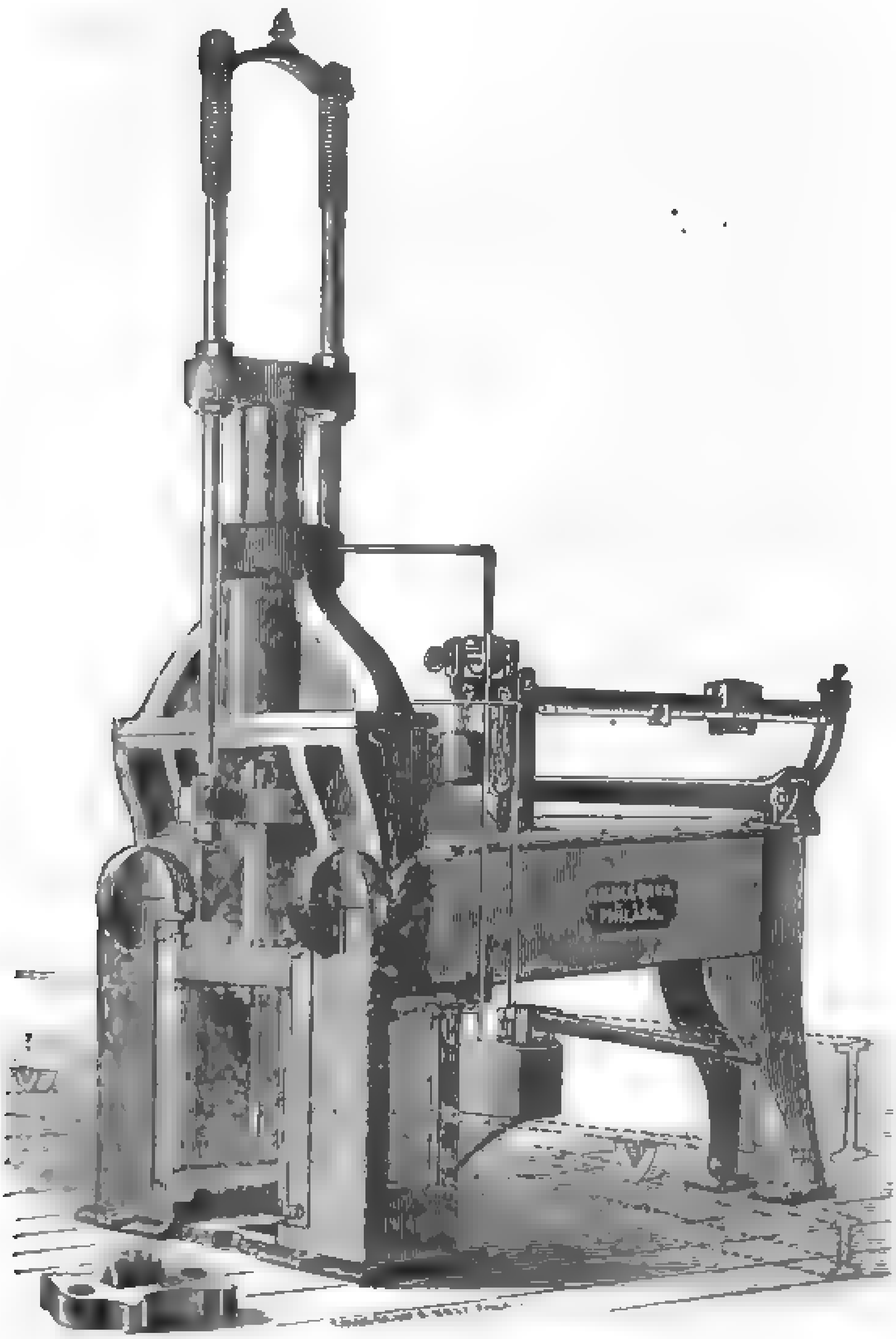


FIG. 7.—100,000 lbs. Gill Screw-Testing Machine used at Cambria Iron Works.

Face page 425.



.—150,000 lbs. Riehlé Hydraulic Testing Machine used at Phœnix Iron Works.

DIMENSIONS.

Extreme height	11 ft.
Extreme length	8 "
Extreme width	6 "
Weight	10,725 lbs.

ADAPTATION.

Tensile specimens	12 in. to 4 ft.
Round "	2½ in. or less
Square "	2 in. x 2 in.
Flat "	3½ in. or less x 1 in. or less.
Transverse "	1 ft. to 4 ft.
Crushing "	2 ft. or less.
" surfaces	8 in. x 12 in.
Motion of plunger	16 in.

slides continuously on the side arm, which is divided by incremei 10 pounds up to 2,000 pounds.

The tensile test pieces were extremely well made, being cut oui planing-machine by a careful workman. Measurements were with a Brown & Sharp's screw-gauge of 1 inch gap and a s gauge of very fine workmanship. Here, as at Johnstown, the widt thickness of the specimen were measured at the middle of the l and near each witness mark, in order to find any defect of area a one place sufficient to cause serious diminution of ductility. In uring test pieces from the finished shapes, the thickness was obt at equal distances from the two edges, on account of the taper thickness of angle flanges, &c. The fractured area was measui at Johnstown, except that the gap-gauge was used.

The values of the principal elastic limit given in the tables f finished material were obtained by noting the cracking of the sc the piece, the beam indications with the slightly leaking valve being reliable.

In making the quenching tests here, the pieces* were heated ; ally in a smith's forge with blast in a hollow fire, either roofed wit coke or with a board laid over the top and covered with pressed Sometimes they were heated in a small furnace burning soft coal one occasion about sixty pieces were placed five or six at a time o top of a close anthracite fire under a small vertical shop boiler, thus slowly heated to exactly the desired temperature and pei uniformly. All of these pieces failed to bend as required, some of cracking all across with bright crystalline fracture at the first b the hammer and with no reduction at the fracture, while second from the same bars heated as usual passed the test well. It is reg that the cause of this behavior could not be exactly defined. It p consists in the surface absorption of some brittle-making element the fuel, most probably of sulphur, though it has been proposed th atmosphere surrounding the pieces being highly carbonaceous (tl was dull, and the pieces were twenty to twenty-five minutes hea the trouble might arise from a surface cementation or absorpt carbon itself. At all events this extreme case illustrates the well-k necessity of using pure fuel in heating, and especially in makii pensive flangings, and points to a possible solution of some o inexplicable fractures of such plates, while it conclusively show the circumstances of making this apparently simple hardenin need some attention.

A moderate blast was used in heating afterwards, and anythin a smoky fire avoided, with a very small proportion of failures.†

The pieces for this test were bent by a fuller under a small stean mer in a hexagon form (used for shaping nuts) to an included an 60°, and then closed under the hammer tup to the desired extent

* The pieces for quenching tests were always the crop-ends of bars, and we erally removed by the hot saw at the rolls. In the event of failure a secon was taken from the perfectly sound bar.

† It may also be mentioned in this connection that the pieces of the finishe rial at Phœnixville behaved very much better under the test than pieces of tl heat tested at Johnstown by the Phœnix Iron Company's inspector, thou former had a rough-sheared edge, the corners only being slightly smoothed the latter were planed out. The pieces tested at Johnstown were generally in the gas-preheating furnace back of the open-hearth steel furnaces, and in an phere of course as little oxidizing as possible. The only essential differei physical condition were the hammering from 7 by 7 inch bloom to a 3-inch Johnstown and one less heating than in most of the finished material.

e total number of heats tested by the Government inspector up ptember 1, 1884, is 152, of which 19, or 12.5 per cent., were rejected, ling three which, after passing the tensile tests, were rejected by hœnix Iron Company's inspector at Johnstown on his preliminary hing test. Of the 133 accepted heats the average tensile strength 34,020 pounds per square inch, with a corresponding average ity of 25.52 per cent. in 8 inches. A complete summary of the s of the tensile tests is given on page 441. Of the material so ed, 1,053 tons were delivered at the ship-yard up to September 1, while 3.41 tons, or .324 per cent., of the amount delivered was re- on the quenching test, and 4.09 tons, or .388 per cent., on the hing and cold tests. Particulars of these tests will be found in neral summary, p. 442.

icient chemical information accompanies the report of tests to the curve of carbon properties (p. 556) to be constructed, illus- g the average behavior of this material under the tensile tests.

chemical methods in use at the Cambria Iron Works for the soft are—for carbon, the color test; for manganese, the acetate of soda omine process; for phosphorus, the molybdate of ammonia process. ing the yellow precipitate after drying always for the same time same temperature. The piece for chemical test was always d from the bloom when cut to length at the blooming-mill.

average carbon of accepted heats was .16$\frac{5}{8}$ per cent.; average horus for 17 heats, .0875 per cent.; average manganese for 50 .443 per cent. This steel carries considerably higher phosphorus ganese than that shipped by any of the other works, yet with urious results. It is to be remembered, however, that it was by a different process.

le VII. gives the results of all tensile tests made on the finished ial at the Phœnix Iron Works. Lot 1 consisted of eight bars from blooms ordered from the Pittsburgh Steel Casting Company, n to be of very fine quality. The bar marked SP2 is one from rimental blooms ordered from the Pennsylvania Steel Com- elton, Pa., and was of too soft material. Analysis gave 5, Mn.=0.387, P=0.044. Lots 18 and 23 are of Cambria Besse- teel, giving the very excellent average of 66,148 pounds tensile th with 24.98 per cent. ductility.

nay be remarked that notwithstanding the excellent tests ob- from Bessemer steel, the Phœnix Iron Company preferred to ore for open-hearth blooms.

e 25 I, which gave the very fine result of 62,513 pounds tensile th, with a final stretch of 30$\frac{1}{8}$ per cent., upon subsequent special is gave C=.155, Mn=.534, P=.089, showing no peculiarity, the nese alone being somewhat above the average.*

figures for the chemical elements in the table are as supplied by anufacturer, from analysis of a chipping from a bloom of the

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*ings for this analysis were taken from that part of the piece which had necked ure.

TABLE VII.—*Cambria steel. Tensile tests of finished material.*

Heat.	Carbon.	Manganese.	Marks.	Original width	Original thickness.	Sectional area.	Elastic limit per square inch.	Ultimate tensile strength per square inch.	Final elongation in 8 inches.	Final width of original width.	Final thickness of original thickness.	Final area of original area.	Time of test.	Size of bar tested.	Nature of steel and remarks.
				Inches.	*Inches.*	*Sq. ins.*	*Pounds.*	*Pounds.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Mins.*		
B. S.	......	....	1 A	1.260	.380	.4788	....	67,356	26.56	72.2	64.0	46.24	16	4 by 3 inch angle	Bessemer steel supplied by Pittsburgh Steel Casting Company.
B. S.	......	....	1 B	1.270	.380	.4826	....	66,307	25.50	72.4	66.7	48.30	15½	do	
B. S.	......	....	1 C	1.270	.380	.4826	....	66,307	25.69	72.4	65.8	47.66	15½	do	
B. S.	......	....	1 D	1.260	.380	.4788	....	67,878	23.12	73.8	66.7	40.20	16	do	
B. S.	......	....	Sp. 2	1.251	.379	.4737	....	57,990	26.94	67.9	57.2	38.86	12	3 by 3 inch angle	Bessemer steel supplied by Pennsylvania Steel Company.
......	......	......	2 B	1.250	.327	.4088	....	62,622	25.63	74.4	65.2	48.53	13	3 by 2½ inch angle	Cambria O. H. Steel. Heat unknown.
......	......	......	2 O	1.250	.327	.4088	....	64,595	25.38	74.9	67.6	50.61	14	do	Do. Do.
......	......	......	3 F	1.245	.327	.4068	....	62,980	27.81	72.8	64.2	46.41	15	do	Do. Do.
......	......	......	3 Q	1.245	.322	.4009	....	62,733	25.63	71.5	64.2	45.87	13½	do	Do. Do.
......	......	......	4 U	1.246	.340	.4236	....	65,156	27.90	73.4	65.3	47.95	15	do	Do. Do.
......	......	......	4 P	1.252	.339	.4244	....	65,386	28.90	72.8	69.8	50.86	15½	do	Do. Do.
......	......	......	5 A	1.248	.330	.4085	....	61,085	26.62	73.5	64.6	47.51	12½	do	Do. Do.
......	......	......	5 B	1.255	.318	.3995	....	63,160	24.38	73.3	65.0	47.64	12½	do	Do. Do.
......	......	......	6 A	1.243	.322	.4002	....	65,842	27.62	76.3	71.3	54.38	15	do	Do. Do.
......	......	......	6 D	1.242	.318	.3949	....	65,052	25.40	72.5	62.0	47.57	14½	do	Do. Do.
......	......	......	7 A	1.241	.318	.3946	....	64,087	28.00	72.5	60.8	44.06	14	do	Do. Do.
......	......	......	7 D	1.252	.327	.4094	....	65,217	26.05	73.9	69.1	51.06	15	do	Do. Do.
4127	.18	.35	8 I	1.240	.300	.3812	....	64,254	26.94	74.1	69.3	51.32	14	do	Cambria O. H. steel.
4140	.17	.54	8 Q	1.253	.315	.3947	....	64,479	28.27	78.3	69.8	51.22	14½	do	Do.
4123	.15	.39	7 N	1.256	.335	.4148	....	67,936	22.40	77.4	71.2	55.13	15½	do	Do.
4130	.21	.67	9 B	1.241	.314	.3896	....	63,530	24.36	74.1	64.8	48.00	14	do	Do.
4130	.21	.37	9 D	1.236	.318	.3930	....	62,596	26.50	72.8	62.9	45.80	13	do	Do.
4124	.18	.55	10 C	1.221	.322	.3932	....	64,600	26.38	74.1	67.0	49.64	14	do	Do.
4124	.15	.55	10 I	1.250	.320	.4000	....	63,373	24.47	74.2	66.2	49.13	14	do	Do.
4139	.21	.37	11 C	1.250	.308	.3850	....	62,727	27.83	73.6	63.2	46.52	13½	do	Do.
4130	.21	.37	11 L	1.238	.413	.5113	....	62,390	26.39	71.6	66.7	47.78	13½	4 by 3 inch angle	Do.
4138	.21	.40	12 B	1.250	.380	.4750	....	64,812	24.44	75.1	67.9	50.95	14½	do	Do.
4134	.21	[illegible]	12 K	1.245	.402	.5005	[illegible]	63,256	24.63	74.0	[illegible]	49.15	14½	do	Do.

4144..	.19	.....	16 D	1.250	.379	.4738	......	62,471	26.78	72.2	69.0	48.05	14	do	Do.
4122..	.15	.28	16 L.	1.210	.340	.4713	......	62,712	24.20	73.5	69.2	50.90	13	...do	Do.
4137..	.15	.35	17 B.	1.250	.348	.4850	......	68,454	25.37	76.0	70.5	53.63	15	...do	Do.
4138..	.15	.30	17 G	1.215	.384	.4777	......	64,784	23.66	74.7	69.9	51.50	14½	...do	Do.
B. S..	......	.....	18 B.	1.227	.330	.4160	......	67,067	25.08	73.6	65.7	48.84	16	3 by 2½ inch angle...	Cambria Bessemer steel.
B. S..	......	.....	18 F	1.226	.331	.4058	......	66,781	23.45	77.1	74.7	57.59	16	......do	Do.
.....	......	.....	19 D	1.232	.346	.4266	......	67,042	26.68	74.5	67.2	49.97	15½	......do	Cambria O. H. steel. Heat unknown.
.....	......	.....	19 E.	1.224	.340	.4162	......	65,833	27.29	73.8	70.3	51.85	15	......do	Do. Do.
4166..	.15	.....	20 A	1.290	.348	.4748	......	62,814	23.88	72.4	63.1	45.66	14	5 by 3 inch angle......	Cambria O. H. steel.
4166	.15	.....	20 C	1.290	.305	.4458	......	63,711	25.78	72.0	66.8	48.09	15	...do	Do.
4166	.15	.....	21 A..	1.234	.388	.4700	......	62,290	25.35	71.6	65.2	46.70	13½	...do	Do.
4166	.15	.....	21 E	1.230	.384	.473		64,884	26.38	72.8	64.7	47.06	14½	...do	Do.
.....	......	.....	22 A	1.231	.378	.4673	42,632	65,011	24.69	73.0	66.4	48.43	17	4 by 3 inch angle......	Cambria O. H. steel. Heat unknown.
.....	......	.....	22 M	1.234	.373	.4603	43,211	65,696	25.12	73.7	67.9	50.00	15	...do	Do. Do.
B. S	......	.....	24 C	1.242	.373	.4505	40,370	67,719	26.38	73.6	66.8	49.14	16½	......do	Cambria Bessemer steel.
B. S	......	.....	23 G	1.234	.377	.4652	41,595	65,026	25.00	74.2	66.7	49.44	16	......do	Do.
4257	.18	.....	25 H	1.242	.340	.4223	41,321	66,777	26.09	74.1	70.0	51.83	17	6 by 3½ inch deck beam	Cambria O. H. steel.
4257	.18	.....	25 I	1.250	.333	.4162	41,206	61,071	28.16	73.0	68.1	49.72	15½	......do	Do.
4257	.18		25 J	1.239	.384	.4758	39,178	64,632	28.95	72.2	67.4	48.65	17	......do	Do.
4263	.20	..	25 L	1.245	.388	.4831	37,777	62,513	30.33	71.8	67.4	48.35	15½	...do	Do.
4257..	.18	.....	25 S	1.265	.415	.5240	43,619	66,095	28.65	72.2	65.6	47.36	19	4 by 3 inch angle......	Do.
4257.	.18	...	26 B	1.270	.410	.5207	41,521	69,714	26.28	78.1	75.0	58.61	19	......do	Do.
4257	.18	...	26 H	1.250	.416	.5200	41,346	65,770	27.58	73.0	64.9	47.40	14½	......do	Do.
4265	.20	...	27 B	1.270	.354	.4496	40,700	65,503	23.86	74.8	68.2	51.00	16½	...do	Do.
4265	.20	...	27 L	1.254	.358	.4489	40,100	65,159	23.10	73.8	65.1	48.01	15½	......do	Do.
4264	.16	..	28 A	1.271	.350	.4449	42,257	66,757	25.19	74.7	69.7	52.10	17½	...do	Do.
4264	.16	..	28 G.	1.255	.368	.4618	38,978	62,148	28.94	71.0	63.7	45.29	15½	......do	Do.
4265	.20	.....	29 C	1.274	.363	.4625	39,780	64,049	24.46	74.2	70.0	52.94	15½	......do	Do.
4265	.20		29 H	1.264	.360	.4550	39,670	63,516	24.86	74.7	69.6	52.00	15½	......do	Do.
4266	.14	.26	30 E	1.256	.363	.4559	38,605	61,638	27.81	72.1	65.1	46.94	15½	......do	Do.
4266	.14	.26	30 H	1.255	.368	.4618	38,761	62,689	25.86	72.2	69.3	50.04	15½	......do	Do.
4266.	.14	.26	31 A	1.268	.367	.4673	39,440	63,830	26.31	72.5	67.3	48.63	14	......do	Do.
4266	.14	.26	31 G..	1.263	.363	.4585	40,350	61,505	29.75	71.7	63.8	45.74	14	...do	Do.
4127	.15	.35	32 B	1.250	.413	.5162	39,209	61,091	23.31	71.0	67.1	48.24	15½	3 by 3 inch angle......	Do.
4127	.15	.35	32 D	1.250	.420	.5062	38,781	62,943	27.93	71.1	68.8	48.91	16½	......do	Do.
4262	.18	.34	33 B	1.252	.451	.5686	39,414	60,538	26.30	72.2	67.4	48.66	17½	......do	Do.
4262	.18	.34	33 G	1.250	.454	.5675	40,352	66,344	26.45	73.6	72.2	53.12	17	......do	Do.
4123	.15	.30	34 F	1.252	.434	.5434	39,560	64,409	27.00	70.9	70.8	50.22	16½	......do	Do.
4122	.15	.28	34 H..	1.252	.425	.5446	38,900	61,972	26.62	70.1	65.1	45.69	13½	do	Do.
4263	.20	.	35 G	1.226	.403	.4049	39,500	64,154	28.50	72.1	65.7	47.33	17½	2½ by 2½ inch angle...	Do.
4263	.20	.....	35 B	1.262	.294	.3710	43,393	65,708	25.80	73.1	68.4	49.88	17½	2½ by 2½ inch angle....	Do.
4261	.15	...	36 B	1.244	.413	.5138	37,758	61,405	24.58	74.4	69.1	51.38	13	5 by 3 inch angle...	Do.
4261	.15		36 G	1.260	.390	.4015	38,658	60,427	25.00	72.2	60.2	43.45	13½	do	Do.
4130..	.21	.37	37 N.	1.266	.303	.3842	39,824	62,728	28.50	73.0	68.8	50.20	13½	2½ by 2½ inch angle...	Do.
4130	.21	.37	37 Q	1.256	.338	.4245	40,050	63,143	25.50	73.7	68.9	50.82	14½	3½ by 3 inch angle....	Do.
4265..	.20	...	38 B.	1.241	.301	.3828	40,643	64,819	25.50	73.6	66.6	48.95	17½	2½ by 2½ inch angle....	Do.
4260..	.18	...	39 B.	1.268	.393	.3715	41,837	64,603	25.50	73.8	69.6	51.38	15	......do	Do.
4260..	.18	......	39 E.	1.260	.385	.4865	38,448	61,924	26.88	71.9	67.6	48.66	14½	5 by 3 inch angle......	Do.
4130..	.21	.37	40 A	1.270	.390	.4953	38,600	64,084	26.11	71.6	64.0	45.88	13½	3½ by 3 inch angle....	Do.

TABLE VII.—*Cambria steel. Tensile tests of finished material*—Continued.

Heat.	Carbon.	Manganese.	Marks.	Original width.	Original thickness.	Sectional area.	Elastic limit per square inch.	Ultimate tensile strength per square inch.	Final elongation in 8 inches.	Final width of original width.	Final thickness of original thickness.	Final area of original area.	Time of test.	Size of bar tested.	Nature of steel and remarks.
				Inches.	*Inches.*	*Sq. ins.*	*Pounds.*	*Pounds.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Mins.*		
4260	.18	......	41 A	1.242	.396	.4918	37,820	61,407	25.60	71.1	65.9	46.85	13½	5 by 3 inch angle	Cambria O. H. steel.
4260	.18	......	41 M	1.248	.421	.5254	38,920	62,809	22.75	73.2	67.0	49.05	14¼	......do	Do.
4258	.18	.26	42 E	1.260	.397	.5002	37,685	62,675	25.74	72.4	67.2	48.62	15	......do	Do.
4258	.18	.26	42 J	1.255	.396	.4970	37,303	63,078	25.53	74.1	71.5	52.96	14½	......do	Do.
4258	.18	.26	43 B	1.255	.408	.5120	37,695	61,719	25.25	72.7	66.0	48.03	14¼	......do	Do.
4258	.18	.26	43 C	1.246	.409	.5096	37,186	58,968	25.63	70.8	63.4	44.58	12½	......do	Do.
4261	.15	......	44 A	1.255	.408	.5120	37,305	62,695	25.92	71.4	65.7	46.90	14	......do	Do.
4261	.15	......	44 H	1.242	.406	.5042	36,690	59,262	29.08	69.8	63.8	44.52	14¼	......do	Do.
4257	.18	......	45 A	1.255	.408	.5120	37,890	67,188	21.63	77.5	71.3	55.29	17¾	......do	Do.
4257	.18	......	45 J	1.244	.411	.5113	37,962	63,466	26.11	72.0	65.0	46.84	16½	......do	Do.
4263	.20	......	46 E	1.255	.399	.5007	39,145	65,708	22.81	70.1	66.2	46.45	18	......do	Do.
4263	.20	......	46 F	1.244	.396	.4926	38,773	63,134	27.63	71.7	65.3	46.84	17½	......do	Do.
4262	.18	.34	47 A	1.257	.414	.5204	39,565	66,007	24.79	73.1	68.8	50.33	17	......do	Do.
4260	.18	......	48 B	1.257	.397	.4990	37,775	62,725	26.60	72.2	68.3	49.32	16½	......do	Do.
4260	.18	......	48 E	1.257	.410	.5154	37,737	61,602	26.10	73.2	65.4	47.82	14½	......do	Do.
4263	.20	......	49 Q	1.240	.383	.4749	37,000	63,808	22.28	74.9	70.1	52.50	14¼	6 by 3½ inch deck beam	Cambria O. H. steel. Broke through deep flaw.

Table VIII. affords a comparison of the tests of $2\frac{1}{2}$ by $\frac{5}{8}$ inch flats at Johnstown with tests of the same heats as finished material at Phœnixville. The form of test piece was the same in both cases. It is seen that with about 60 per cent. of the thickness and sectional area of the test pieces taken from the flats, about 70 per cent. of the reduction of area in the rolls from the ingot, and 63 per cent. greater reduction of thickness from the ingot, the finished material shows a gain of 2,359 pounds, or 3.85 per cent. in tensile strength, while the ductility remains unchanged. The interest of the comparison is, however, interfered with by the fact that the tests were made on different machines. Thus, taking the results of the special comparative tests of material on each machine with tests of corresponding pieces of the same material on the machine at the Washington navy-yard (p. 525), we find that the Gill machine at Johnstown showed 160 pounds less, while the Riehlé at Phœnixville showed 2,610 pounds more, than the Rodman at the navy-yard for results from 60,500 to 63,500 pounds. Thus the apparent excess of the Riehlé over the Gill machine between these loads is 2,770 pounds. It is not believed, however, that this difference is, even in great part, due to differences in the machines, for it will be observed that the lower tensile strength obtained from the Phœnixville material at the navy-yard is accompanied by considerably greater ductility.

If we admit the accuracy of the machines and neglect the influence of the difference in thickness of test piece, the gain of 3.85 per cent. in tensile strength of the finished material would appear to be due essentially to its increased work of reduction of thickness from the ingot, the proportion being 1.63 to 1.

Upon this comparison, taking the shapes in the table as a fair average for the whole order, was based the size of the flat, 6 inches by $\frac{3}{16}$-inch, subsequently adopted as representing the average finished material for purposes of test, this flat having almost exactly the same amount of reduction of area from the ingot as the above average for finished shapes, while the reduction of thickness allows a margin in being less than the average for the finished shapes in the proportion of 37 to 42.3.

It may be remarked that if the probable influence on the ductility of the law of proportion of the test piece (to be discussed later) be taken into account, the ductility of the material tested at Johnstown would have been only 25.65 instead of 26.05 per cent. if tested in a piece of dimensions proportionate to those of the test pieces used at Phœnixville. The inference, therefore, is that the increased work of reduction from the ingot has affected an increase of both tensile strength and ductility.

TABLE VIII.—*Comparative tests of material of the same heats, with different amounts of work of reduction from the ingot.*

Heat.	Carbon.	Manganese.	Average sectional area.	Average ultimate tensile strength per square inch.	Average final elongation in eight inches.	Time.	Average original thickness	Average reduction of area from the ingot.	Average reduction of thickness from the ingot.	Number of tests.	Size of bars tested.
			Sq. inches.	*Pounds.*	*Per cent.*	*Min.*					
4,121	14	....	.7669	60,372	26.37	25	.610	142.5	26.23	1	Flats, 2½″ by ⅝″.
4,121	14	....	.4842	62,978	28.68	14	.388	97.0	41.24	2	Angle, II of 4″ by 3″ by 9 lbs.
4,122	15	28	.7699	59,485	29.75	21	.610	142.5	26.23	1	Flat, 2½″ by ⅝″.
4,122	15	28	.5011	62,377	25.32	13¼	.402	100.0	39.80	3	Angle, II of 4″ by 3″ by 9 lbs.; I of 3″ by 3″ by 8 lbs.
4,123	15	39	.7875	62,603	23.50	20	.625	142.5	25.60	1	Flat, 2½″ by ⅝″.
4,123	15	39	.4816	64,522	25.25	15	.387	109.0	41.85	4	Angle, II of 4″ by 3″ by 9 lbs.; I of 3″ by 3″ by 8 lbs.; I of 3″ by 2½″ by 6 lbs
4,124	15	55	.7506	60,110	26.12	20	.605	142.5	26.45	1	Flat, 2½″ by ⅝″.
4,124	15	55	.3066	63,966	25.40	14	.321	142.5	49.85	2	Angle, II of 3″ by 2½″ by 6 lbs.
4,127	15	35	.7688	61,549	20.25	20	.620	142.5	25.81	1	Flat, 2½″ by ⅝″.
4,127	15	35	.4707	64,411	25.89	15½	.384	112.5	41.66	4	Angle, II of 3″ by 3″ by 8 lbs.; I of 4″ by 3″ by 9 lbs.; I of 3″ by 2½″ by 6 lbs.
4,134	21	50	.7688	60,939	22.87	18¼	.615	142.5	26.02	1	Flat, 2½″ by ⅝″.
4,134	21	59	.4907	63,703	24.24	15	.394	97.0	40.60	2	Angle, II of 4″ by 3″ by 9 lbs.
4,138	21	40	.7844	62,408	25.50	17	.625	142.5	25.60	1	Flat, 2½″ by ⅝″.
4,138	21	40	.4820	63,897	25.60	13¾	.387	97.0	41.85	3	Angle, III of 4″ by 3″ by 9 lbs.
4,139	21	37	.7530	61,752	24.80	13	.600	142.5	26.67	1	Flat 2½″ by ⅝″.
4,139	21	37	.4261	62,784	26.17	14	.340	127.0	47.05	7	Angle, III of 3″ by 2½″ by 6 lbs.; II of 3″ by 2½″ by 8 lbs.; I of 4″ by 3″ by 9 lbs.; I of 2½″ by 2½″ by 5 lbs.
4,140	17	54	.7812	62,084	23.00	16	.620	142.5	25.81	1	Flat, 2½″ by ⅝″.
4,140	17	54	.4329	64,193	27.64	14½	.347	116.0	46.34	2	Angle, 4″ by 3″ by 9 lbs.; 3″ by 2½″ by 6 lbs.
4,160	15	....	.7380	62,331	24.75	22	.600	142.5	26.67	1	Flat, 2½″ by ⅝″.
4,160	15	....	.4772	62,807	25.85	14½	.388	87.0	41.24	4	Angle, IV of 5″ by 3″ by 10 lbs.
4,257	18	....	.7540	63,597	28.50	22	.612	142.5	26.15	1	Flat, 2½″ by ⅝″.
4,257	16	....	.4879	65,914	26.79	17	.390	73.0	41.03	6	Angle, III of 4″ by 3″ by 9 lbs.; II of 5″ by 3″ by 10 lbs.; d'k b'ms, III of 6″ by 3½″ by 16 lbs.
4,258	18	26	.7906	60,460	25.60	19	.635	142.5	25.20	1	Flat, 2½″ by ⅝″
4,258	18	26	.5047	61,610	25.54	14	.403	87.0	39.70	4	Angle, IV of 5″ by 3″ by 10 lbs.
4,260	18	....	.7797	59,002	20.40	17½	.628	142.5	25.48	2	Flat 2½″ by ⅝″
4,260	18	....	.4819	62,512	25.49	14½	.400	95.0	40.00	6	Angle, V of 5″ by 3″ by 10 lbs.; I of 2½″ by 2½″ by 5 lbs.
4,261	15	....	.7719	59,088	28.40	17½	.620	142.5	25.81	1	Flat, 2½″ by ⅝″
4,261	15	....	.5054	60,947	20.15	13¾	.404	87.0	39.60	4	Angle, IV of 5″ by 3″ by 10 lbs.
4,262	18	34	.7874	62,979	26.80	22	.635	142.5	25.20	1	Flat 2½″ by ⅝″
4,262	18	34	.5525	60,296	25.85	17½	.441	100.5	36.29	3	Angle, II of 3″ by 3″ by 8 lbs.; I of 6″ by 3″ by 10 lbs.
4,263	20	....	.7874	62,230	24.50	21	.635	142.5	25.20	1	Flat, 2½″ by ⅝″
4,263	20	...	.4095	64,180	26.19	10¾	.377	81.5	42.45	6	Angle 2½″ by 2½″ by 7½ lbs.; 2½″ by 2½″ by 6 lbs.; II of 5″ by 3″ by 10 lbs.; d'k b'ms, II of 6″ by 3½″ by 16 lbs.

4, 266	20	....	.7626	62, 164	27.00	20¼	.610	142.5	36.23	1	Flat, 2½″ by ⅜″.
4, 265	20	....	.4397	64, 729	24.77	16	.347	117.5	46.11	5	Angle, IV of 4″ by 3″ by 8 lbs.; I of 2½″ by 2½″ by 5 lbs.
4, 296	14	26	.7530	60, 591	27.90	16¼	.600	142.5	26.67	1	Flat, 2½″ by ⅜″.
4, 296	14	26	.4604	62, 688	27.43	14¾	.365	109.0	43.83	4	Angle, IV of 4″ by 3″ by 8 lbs.

AVERAGES.

....	17.16	39.36	.7694	61, 272	26.05	19½	.6174	142.5	25.94	20	Flat, 2½″ by ⅜″. Tested on Gill machine, Johnstown, Pa.
....	17.16	39.36	.4741	63, 631	26.05	15	.3802	102.3	42.31	75	Finished shapes. Tested on Riehlé machine, Phœnixville, Pa.
Ratio of averages; finished shapes to test flats			.6162	1.0385	1.00	......	.6158	.7178	1.63	....	

Table IX. gives the results of tensile tests by heats at Johnstown, on material made after the instructions of October 6 were received. The average dimensions of test pieces are given, inasmuch as they are held to influence the results. Under the column headed "Elongation at maximum load" is given the stretch of the piece at the instant the beam drops with the maximum load; it is therefore a trifle greater than the extension corresponding to the highest point of the curve in a strain diagram. The corresponding stretched length was measured with an ordinary pair of dividers. The column of "Final stress in pounds per square inch of fractured area" was obtained by running down the weights while the piece was necking. This could not be done with the machine used so as to be strictly accurate for individual cases, but the average for each heat is believed to be fairly correct, except as affected by error in final area. The regularity is somewhat remarkable, the values ranging ordinarily from 100,000 to 110,000 pounds per square inch, and averaging 104,550 pounds for 31 accepted heats. Any marked defect in this quality would appear to indicate lamination or lack of uniform structure, since traces of lamination in the fracture are invariably accompanied by low values of final strength. We shall have something to say of this quality further on.

It will be observed that many of the failures towards the last are due to frequent breaks in the manufacture, the melters finding it very difficult to make a heat of soft steel of the required quality immediately after making a heat of spring steel in the same furnace.

The longest successful run is 32 heats.

Heat	Carbon	Manganese	Average original t…	Average … original … (?)	Average sectional …	Average elastic li… square inch	Average ultimate strength per squa…	Average final elo… in … inches.	Average final w… original widt…	Average final thick… original thickn…	Average final area … inal area	Average time of te…	Average elongation … first stress of … pounds per squa…	Corresponding mo… elasticity	Average elongation … imum load.	Average final str… square inch of fr… area.	Number of tests.	Accepted or rejecte…	Remarks.
			Inches	Inches	Sq. ins	Pounds	Pounds	Per ct	Per ct	Per ct	Per ct.	Mins							
4285	.10		1.236	.4368	5423	37,760	62,147	26.15	73.62	70.35	51.82	15¾	....	....	.....	....	4	A.	Test-plate 12 inches by $\frac{7}{8}$ inch
4301			1.239	.4308	5336	38,860	62,461	25.80	73.53	69.48	51.09	15	....	....	.....	....	4	A.	Do.
4300	.10		1.254	.3785	4747	43,880	60,322	24.08	74.74	70.64	52.04	17½	....	....	.....	....	4	R.	Test-plate 12, inches by $\frac{7}{8}$ inch. One piece gave 20.2 per cent. elongation.
4324	.14	.18	1.2[illegible]	.4775	.6011	49,402	64,149	24.53	73.39	68.98	51.37	16½	....	....	.....	....	4	A.	
4325	.14		1.257	.4675	.5867	42,015	63,874	25.25	73.50	65.06	47.73	15¾	....	....	.....	....	4	A.	
4330	.16		1.247	.4648	.5798	44,708	64,937	24.08	77.65	68.13	52.40	17	....	....	.....	....	4	A.	
4331	.14		1.215	.4715	.5871	41,091	63,657	26.48	73.27	67.77	49.64	16¼	....	....	.....	....	4	A.	
4333	.15		1.234	.4563	.5681	44,536	63,455	24.85	74.96	60.60	45.75	16¼	....	....	.....	....	4	A.	
4338	.14		1.244	.4757	.5919	43,929	65,021	21.70	84.51	74.34	62.27	16¾	....	....	.....	....	3	R.	One piece gave 20 per cent. elongation.
4339	.16		1.248	.4625	.5774	40,807	65,791	23.85	78.82	73.14	57.98	17	....	....	.....	....	4	A.	
4340	.13		1.226	.4713	.5777	38,168	59,321	25.80	72.08	62.76	45.47	15½	....	....	.....	....	4	R.	
4341	.14		1.250	.4500	.5734	39,395	63,144	20.50	69.26	65.57	45.03	16¼	....	....	.....	....	4	A.	
4342	.15		1.255	.4576	.5756	42,809	64,452	23.48	76.65	71.80	54.83	16¾	....	....	.....	....	8	A.	
4358	.13		1.246	.4415	.5499	45,233	64,161	25.95	77.34	69.41	53.27	17½	....	....	.....	....	4	A.	
4360	...		1.247	.4203	.5355	43,740	60,652	27.15	72.84	64.45	46.91	16¼	....	....	.....	....	4	A.	
4366	.17		1.251	.4330	.5416	43,864	66,095	24.88	74.15	70.24	52.05	19¼	....	....	.....	....	4	A.	
4421	.18		1.282	.4360	.5559	43,156	65,568	24.73	72.95	60.50	49.05	16¼	....	....	.....	....	4	A.	Phosphorus .07 per cent.
4422	.20		1.256	.4365	.5491	45,440	69,426	24.48	74.32	69.87	51.95	19¼	....	....	.....	....	4	A.	
4424	.21		1.272	.4225	.5373	47,218	69,798	23.38	76.39	68.44	52.27	19	....	....	.....	....	4	A.	
4427	.15		1.256	.4290	.5388	45,093	65,232	23.80	73.84	64.10	47.27	17	....	....	.....	....	4	A.	
4425	.18		1.271	.4423	.5610	44,745	67,798	22.90	73.89	69.51	51.60	19	....	....	.....	....	3	R.	One piece gave 19.5 per cent. elongation, breaking near shoulder
4430	.17	..	1.258	.4380	.5509	42,445	65,269	25.88	73.92	69.53	51.39	17	....	....	.....	....	4	A.	
4431	.20		1.267	.4388	.5519	44,930	68,280	23.60	77.87	73.12	57.30	18¼	....	....	.....	....	4	A.	
4432	.16	.22	1.251	.4328	.5412	41,119	65,597	24.23	76.27	67.58	51.55	19¼	....	....	.....	....	4	A.	
4433	.15	.79	1.238	.4318	.5327	40,065	62,910	24.80	76.01	72.18	54.17	16	....	....	.....	....	4	A.	
4434	.12	.81	1.236	.4478	.5534	38,358	61,348	26.03	73.72	69.18	51.00	16¼	....	....	.....	....	4	A.	
4435	.15		1.340	.4500	.5580	48,116	68,649	25.40	75.09	69.72	52.25	17¾	....	....	.....	....	4	A.	

TABLE IX.—*Cambria steel. Tensile tests by heats*—Continued.

Heat.	Carbon.	Manganese.	Average original width.	Average original thickness.	Average sectional area.	Average elastic limit per square inch.	Average ultimate tensile strength per square inch.	Average final elongation in 8 inches.	Average final width of original width.	Average final thickness of original thickness.	Average final area of original area.	Average time of test.	Average elongation under first stress of 30,000 pounds per square inch.	Corresponding modulus of elasticity.	Average elongation at maximum load.	Average final stress per square inch of fractured area.	Number of tests.	Accepted or rejected.	Remarks.
			Inches.	*Inches.*	*Pounds.*	*Pounds.*	*Sq. ins.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Mins.*							
4436	.12	.42	1.251	.4448	.5549	41,820	64,251	25.95	74.24	67.45	50.10	18½					4	A.	
4437	.17	.34	1.248	.4458	.5564	38,758	60,603	26.75	70.70	65.81	46.47	16					4	A.	
4438	.18	.26	1.235	.4488	.5542	41,761	65,200	25.95	76.01	70.75	53.97	17½					4	A.	
4439	.16		1.255	.4435	.5565	40,832	62,638	26.80	74.11	68.3[illegible]	50.65	17¾					4	A.	
4441	.12		1.250	.4375	.5469	42,692	61,377	23.95	75.20	67.70	51.20	16½					4	A.	One piece broke through a flaw, with only 21.6 per cent. elongation
4445	.18		1.239	.4450	.5513	42,363	66,936	23.53	78.09	73.77	57.65	18¾					4	A.	
4447	.14	.54	1.239	.4350	.5389	41,203	66,367	25.65	76.80	70.97	54.05	18					4	A.	
4449	.16	.42	1.239	.4550	.5636	38,176	61,229	27.13	72.64	68.67	49.90	17					4	A.	
4450	.11	.40	1.248	.4400	.5489	43,135	62,081	26.23	73.64	68.72	46.90	16½					4	A.	
4452	.18	.64	1.244	.4300	.5348	45,399	70,460	24.15	75.73	71.54	54.91	19¾					8	A.	
4453	.17	.37	1.244	.4500	.5597	41,640	64,320	24.23	73.70	69.62	51.40	15¾					4	A.	
4454	.14	.29	1.241	.4400	.5461	40,477	62,307	26.63	73.21	68.98	50.50	15					4	A.	
4457	.16		1.245	.4400	.5478	45,880	67,234	26.10	74.49	70.03	52.07	19¾					4	A.	
4458	.16		1.243	.4400	.5467	43,750	66,045	25.90	73.84	69.60	51.45	16¾					4	A.	
4459	.15	.44	1.240	.4350	.5394	45,094	65,230	26.23	72.17	68.78	49.35	17					4	A.	
4460	.16		1.235	.4375	.5403	45,850	66,098	25.90	70.34	60.39	42.52	17¼					4	A.	
4461	.16		1.240	.4325	.5363	43,594	66,824	24.78	73.09	71.58	52.82	17¼					4	A.	
4462	.17	.56	1.243	.4300	.5343	43,375	61,984	27.45	72.43	69.86	49.38	17¾					4	A.	
4463	.13		1.240	.4450	.5518	39,080	62,607	27.85	71.58	64.50	46.15	16½					4	A.	
4464	.15		1.240	.4450	.5518	42,400	69,398	25.63	74.39	70.51	52.42	19¼					4	A.	
4465	.12		1.245	.4300	.5353	39,797	60,576	25.96	73.08	67.37	49.97	15					8	A.	
4466	.16		1.240	.4425	.5487	38,154	62,021	27.00	69.75	63.93	44.62	14½					4	A.	
4468			1.240	.4400	.5456	39,925	64,639	25.78	70.66	64.58	45.60	15½					4	A.	
4470	.18		1.237	.4400	.5445	38,117	63,503	25.95	71.00	62.40	44.30	[illegible]					4	A.	
4478			1.246	.4300	.5358	40,542	60,380	26.40	74.76	67.80	50.72	15					8	A.	
4501	.14		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	[illegible]	

..	[illegible]	.....	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	75.69	[illegible]34	52.52	17	....	....	....	....	4	A.	
..	.20	.....	1.249	[illegible]	.5494	40, [illegible]	[illegible], 002	24.68	75.87	[illegible].12	52.52	18	....	....	....	....	4	A.	
[illegible]	.17	.....	1.250	.4400	.5500	40,499	63,273	26.70	73.80	67.04	49.85	15¾	....	....	....	....	4	A.	
4553..	.19	.....	1.250	.4400	.5500	40,999	64,567	26.15	73.60	69.12	51.32	16¾	....	....	....	....	4	A.	
4558..	.19	.....	1.245	.4175	.5198	46,085	66,244	24.45	79.31	74.25	58.92	18¼	....	....	....	....	4	A.	
4561..	.16	.....	1.245	.4375	.5447	41,215	63,262	23.00	79.72	78.09	61.57	15¼	....	....	....	....	4	A.	
4600..	.....	.....	1.258	.4200	.5281	45,561	63,706	23.70	74.95	68.68	51.45	17⅛	....	....	....	....	4	A.	
4674..	.14	.....	1.252	.6510	.8150	37,858	60,028	25.93	77.79	75.21	58.62	21⅛	....	....	....	....	4	A.	
4678..	.16	.32	1.253	.6250	.7829	39,285	64,133	24.53	79.47	72.02	57.57	21	....	....	....	....	4	A.	
4681..	.16	.32	1.252	.6250	.7828	38,370	61,215	25.33	75.37	73.40	55.36	17½	....	....	....	....	4	A.	
4682..	.17	.....	1.254	.6250	.7839	40,020	63,163	24.55	82.93	77.79	64.57	18¼	....	....	....	....	4	A.	
4684..	.12	.32	1.257	.6235	.7819	37,313	60,013	25.48	76.71	73.90	56.85	15¼	....	....	....	....	4	A.	
4686..	.14	.32	1.254	.6265	.7852	38,933	62,268	26.15	74.47	73.66	54.85	16½	....	....	....	....	4	A.	
4700..	.16	.....	1.260	.4300	.5427	43,023	66,128	23.90	78.25	74.53	58.27	18¼	....	....	....	....	4	A.	
4709..	.15	.....	1.262	.4542	.5734	39,690	60,605	26.58	75.24	67.02	50.42	15¼	*.01079	25,950,000	....	....	4	A.	
4711..	.11	.....	1.259	.4510	.5678	39,765	60,998	25.48	76.16	72.00	54.87	14¾	*.010025	27,930,000	....	....	4	A.	
4712..	.23	.....	1.256	.4439	.5578	46,768	70,824	23.46	78.79	76.86	60.57	20¼	*.00989	28,320,000	....	....	8	A.	One piece broke through flaw, with only 20 per cent. elongation.
4713..	.15	.....	1.259	.4648	.5851	40,040	62,560	22.98	77.63	74.05	57.72	15¾	*.01041	26,900,000	....	....	4	A.	
4715..	.15	.....	1.001	.4350	.4354	42,095	63,690	25.03	72.94	67.52	49.27	16¾	*.01067	26,240,000	....	....	4	A.	
4716..	.14	.....	1.261	.4265	.5379	40,845	63,533	20.93	74.24	73.21	54.40	17	*.01039	26,950,000	....	....	4	A.	
4718..	.14	.52	1.256	.4447	.5585	43,470	65,418	25.15	76.54	69.81	53.47	17¼	*.00947	2[illegible],570,000	....	....	4	A.	
4767.	.09	.37	1.268	.4148	.5261	37,038	58,920	27.05	72.44	67.93	49.25	15	....	....	....	....	4	R.	
4779..	.13	.....	1.268	.4538	.5751	37,498	59,375	27.43	71.47	64.51	46.10	17½	.00926	25,920,000	....	....	4	R.	
4782..	.18	.....	1.240	.4560	.5694	42,800	64,880	20.50	78.06	76.53	59.70	19	.00985	24,360,000	....	....	1	R.	
4794..	.24	.90	1.225	.4405	.5396	42,210	66,125	24.35	72.75	72.19	51.67	17¼	*.00995	28,140,000	....	....	4	A.	
4796..	.19	.....	1.260	.4438	.5591	44,375	64,608	25.70	76.18	68.90	52.50	16½	*.009065	30,890,000	....	....	4	A.	
4823..	.19	.....	1.258	.4252	.5350	39,140	62,463	27.83	74.54	70.95	53.07	†16¼	*.01069	26,190,000	....	....	4	A.	
4825..	.22	.....	1.257	.4408	.5540	39,090	63,220	24.83	78.55	72.25	56.77	21	*†.00988	28,340,000	....	....	4	A.	
4843..	.23	.....	1.255	.4440	.5574	41,580	65,035	27.18	72.48	66.67	48.37	18⅛	*.00963	29,080,000	21.68	113,230	4	A.	
4847..	.20	.....	1.258	.4535	.5702	39,458	62,473	25.03	77.21	72.31	55.80	18¼	*.01030	27,180,000	21.23	101,219	4	A.	
4849..	.20	.....	1.257	.4332	.5445	45,125	70,245	23.75	80.76	76.22	59.55	19¾	*.01011	27,700,000	19.18	105,660	4	A.	
4851..	.18	.38	1.260	.4352	.5483	40,488	62,620	26.60	75.21	67.94	51.15	15¾	*.010325	27,120,000	20.65	106,042	4	R.	Rejected on quenching test by Phœnix Iron Company's inspector.
4853..	.17	.55	1.260	.4305	.5426	41,608	61,200	24.90	78.45	67.60	52.97	15¾	*.01004	27,890,000	20.43	101,518	4	R.	One piece gave 20.4 per cent. elongation.
4855	.20	.....	1.249	.4537	.5666	43,400	65,618	24.28	79.04	73.93	58.45	19¾	*.01045	26,790,000	†19.70	100,950	4	A.	
4857..	.18	.....	1.250	.4355	.5445	43,250	66,078	24.40	79.60	72.67	57.55	19¼	*.01084	25,830,000	20.58	‡103,200	4	A.	
4861..	.17	.....	1.249	.4318	.5398	37,818	61,235	27.20	73.72	69.07	50.77	17¼	*.01077	26,000,000	21.03	106,875	4	R.	Rejected on quenching test by Phœnix Iron Company's inspector.
4873..	.13	.....	1.261	.4450	.5614	38,760	62,340	28.17	.....	.....	53.47	.....	....	....	....	....	3	A.	
4875..	.14	.....	1.250	.4390	.5488	33,210	55,400	28.60	68.56	64.23	44.00	14	....	....	....	....	1	R.	
4876..	.12	.....	1.256	.4480	.5619	37,638	60,055	26.68	75.22	70.98	53.57	16	.00871	27,550,000	20.95	†100,467	4	A.	

* For 35,000 pounds. † Mean of three pieces. ‡ Mean of two pieces.

TABLE IX.—*Cambria steel. Tensile tests by heats*—Continued.

Heat.	Carbon.	Manganese.	Average original width.	Average original thickness.	Average sectional area.	Average elastic limit per square inch.	Average ultimate tensile strength per square inch.	Average final elongation in 8 inches.	Average final width of original width.	Average final thickness of original thickness.	Average final area of original area.	Average time of test.	Average elongation under first stress of 30,000 pounds per square inch.	Corresponding modulus of elasticity.	Average elongation at maximum load.	Average final stress per square inch of fractured area.	Number of tests.	Accepted or rejected.	Remarks.
			Inches.	*Inches.*	*Sq. ins.*	*Pounds.*	*Pounds.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Mins.*							
4877..	.16	....	1.255	.4290	.5384	40,865	65,685	25.15	75.00	70.16	52.75	18¾	.008725	27,510,000	19.43	108,275	4	A.	
4879..	.15	....	1.251	.4340	.5443	39,640	63,350	25.93	74.26	71.36	52.27	18	.00861	27,875,000	21.53	103,475	4	A.	
4881..	.14	....	1.255	.4328	.5431	38,068	61,540	25.58	73.00	69.03	50.42	17	.008625	27,830,000	19.68	105,400	4	A.	
4904..	.15	....	1.246	.4535	.5650	41,343	68,095	23.18	77.66	74.85	58.12	17	....	....	....	....	4	R.	One piece gave 20.7 per cent. elongation
4905..	.14	.40	1.249	.4578	.5468	37,075	61,713	26.28	70.72	65.45	46.30	15¾	.00884	27,150,000	20.20	111,000	4	A.	
4907..	.16	...	1.254	.4438	.5565	40,035	64,923	24.68	77.35	71.72	55.50	18½	.00849	28,270,000	19.13	103,650	4	A.	
4908..	.14	....	1.252	.4160	.5206	39,615	62,588	26.53	73.47	68.80	50.57	16½	.00844	28,437,000	20.25	104,825	4	A.	
4917..	.13	.43	1.245	.4180	.5204	41,520	62,070	20.70	82.16	66.26	54.50	16	.00810	29,610,000	18.20	101,300	1	R.	
4918..	.14	....	1.244	.4373	.5438	39,080	62,818	25.43	75.59	73.12	55.27	19	.00801	29,960,000	20.55	100,193	4	A.	
4919..	.14	....	1.245	.4450	.5539	40,620	64,093	24.98	76.52	72.41	55.42	17	.00869	27,620,000	20.23	101,150	4	A.	
4920..	.14	....	1.244	.4380	.5447	38,593	62,380	27.80	71.46	64.55	46.15	17¾	.00935	25,670,000	20.93	113,150	4	A.	
4921..	.15	....	1.249	.4337	.5415	39,875	61,680	24.23	73.68	67.37	49.67	18¼	.009725	24,680,000	21.15	107,875	4	A.	
4922..	.15	....	1.247	.4318	.5382	38,925	60,743	25.90	71.39	68.84	49.17	17¼	.008925	26,890,000	21.50	104,250	4	A.	
4934..	.16	....	1.254	.4220	.5289	41,283	65,375	24.15	78.57	74.27	58.62	18½	.008825	27,195,000	19.00	101,293	4	A.	
4950..	.17	.48	1.240	.4380	.5431	46,770	68,960	21.30	81.33	79.10	64.35	20½	.007625	31,475,000	19.00	99,630	2	R.	One piece gave 20.3 per cent. elongation.
4951..	.16	....	1.256	.4405	.5533	41,628	63,598	23.78	77.59	74.72	58.05	19¼	.00828	28,985,000	19.94	98,904	8	A.	
4952..	.14	....	1.251	.4413	.5518	42,473	64,278	23.00	77.06	73.39	56.69	18	.00828	28,985,000	18.95	100,806	8	A.	
4953..	.17	....	1.247	.4418	.5506	43,588	67,835	24.60	76.81	71.30	54.77	19¼	.00871	27,550,000	19.13	107,675	4	A.	
4981..	.14	....	1.247	.4487	.5595	37,558	59,481	27.90	71.47	68.71	48.80	15¾	.00887	27,060,000	22.24	101,018	8	R.	
4983..	.14	....	1.252	.4410	.5520	37,725	61,870	23.55	78.19	75.33	58.72	16¼	.009275	25,877,000	19.13	94,685	4	A.	
4984..	.15	....	1.248	.4427	.5512	38,783	61,015	26.03	74.34	71.70	53.22	16	.008625	27,830,000	20.25	100,445	4	A.	
5003..	.18	....	1.246	.4285	.5339	41,780	65,140	19.80	83.46	80.62	67.67	16½	.00885	27,120,000	17.75	91,160	2	R.	
5015..	.15	....	1.269	.4433	.5617	40,373	63,545	26.20	73.29	66.78	48.92	16½	.00874	27,460,000	20.75	108,675	4	A.	
5016..	.14	....	1.261	.4443	.5640	39,015	62,440	27.03	74.22	68.37	50.75	16	.008775	27,350,000	20.25	104,725	4	A.	
5216..	.17	....	1.254	.4522	.5670	40,269	61,778	24.88	74.65	67.80	50.47	......	.00828	29,055,000	......	108,900	4	A.	
5219..	.14	....	1.261	.4483	.5654	37,631	61,267	26.25	75.54	65.56	48.23	......	.00820	29,270,000	......	109,216	4	A.	
5220..	.16	...	1.268	.4565	.5788	35,793	63,912	26.00	73.04	66.90	48.87	......	.00910	26,370,000	......	109,506	4	A.	
5221..	.15	.49	1.260	.4423	.5573	38,176	62,608	25.54	76.58	71.12	54.43	......	*.00800	30,000,000	......	99,758	4	A.	
5253..	.18	....	1.251	.4378	.5476	30,162	60,756	24.48	76.23	68.95	52.38	......	*.00895	26,810,000	......	102,581	4	A.	
5255..	.11	....	1.248	.4463	.5507	40,442	62,279	26.08	73.74	68.52	50.45	......	.00820	29,270,000	......	105,983	4	A.	

* Mean of three pieces.

ollowing general summary gives in brief the results of the phys-
;s of the Cambria open-hearth steel supplied:

Summary of tensile tests. Cambria open-hearth steel.

ensile tests by heats were made from 6-inch by $\frac{7}{16}$-inch flat on Gill screw machine, at Cam Works, Johnstown, Pa. Tensile tests on finished material were made on Riehlé hydraulic at Phœnix Iron Works, Phœnixville, Pa.]

	Tensile tests by heats.				Tensile tests on finished accepted material.	Tensile tests on all accepted material.
	Accepted material.	Material rejected for lack of ductility.	Material rejected for lack of strength.	Material rejected on quenching test.		
heats	114	10	6	3	19	133
tests	483	21	22	12	91	574
ırbon in per cent	*a* .1605	.162	.1333	.1666	.1716	.1622
riginal width of cross-	1.248	1.248	1.252	1.253	1.250	1.249
›riginal thickness of tion	.4539	.4322	.4446	.4390	.3724	.4423
riginal area of cross-	.5624	.5396	.5566	.5519	.4637	.5483
lastic limit in pounds re inch	41,440	44,133	36,796	*b*39,153	*c*39,450	*d*41,247
timate tensile strength s per square inch	64,057	65,871	58,284	62,640	63,800	64,020
ongation in 8 inches in	25.42	21.91	27.11	26.02	26.11	25.52
nal width in per cent. l width	*e*75.04	80.09	70.72	*b*74.47	73.14	*f*74.76
nal thickness in per riginal thickness	*e*69.88	73.97	65.37	*b*68.51	66.97	*f*69.46
nal area in per cent. of ırea	52.85	60.36	46.35	53.62	49.12	52.32
ılus of elasticity	24,680,000	24,360,000	25,920,000	26,000,000	....	24,680,000
odulus of elasticity	30,890,000	31,475,000	27,060,000	27,120,000	....	30,890,000
odulus of elasticity	*g*27,720,000	*h*28,091,000	*b*26,490,000	*b*26,560,000	....	*g*27,720,000
ongation at maximum	*i*20.17	*j*18.85	*k*22.24	*b*20.84	....	*i*20.17
ıal strength in pounds e inch of fractured area	*l*104,550	*j*98,402	*k*101,018	*b*106.459	....	*l*104,550
ne of test in minutes	*m*17½	17¾	15¼	*b*16½	15	*n*17

109 heats. *e* For 113 heats. *i* For 25 heats. *m* For 107 heats.
2 heats. *f* For 132 heats. *j* For 4 heats. *n* For 126 heats.
10 heats. *g* For 42 heats. *k* For 1 heat.
124 heats. *h* For 5 heats. *l* For 31 heats.

SUMMARY OF TESTS AND INSPECTION.

ıllowing general summary gives the principal particulars of tests pection in the aggregate. It is seen that out of 880 heats tested ıt September, 1884, only 146, or 16.6 per cent., were rejected, and ount would have been further diminished if the orders for boiler uld have been issued sooner, notably in the case of the Norway any heats of which, too soft for ship metal, passed satisfactory r boiler metal, but were rejected for lack of orders. The very mount of material rejected on the quenching test, after being d by heat tests, is still sufficient to call attention to the efficiency test; increasing familiarity of manufacturers with the require- ıd method of tests would still further diminish the amount so . The necessity for this test, nevertheless, exists in that it is to h piece and prevents all possibility of serious defect aris- nt subsequent to casting or of mistake at works pro- ıy g es of steel.

General summary of results for all steel plates and bars delivered up to September

Manufacture of steel.	Weight in tons delivered up to September 1, 1884.	Average ultimate tensile strength per square inch.	Average final elongation.	Efficiency number.*	Energy required to break a bar 1 sq. inch sect. area and 8 inches long between fillets.†	Weight in tons rejected on quenching test.	Number of heats accepted.	Number of heats rejected on tensile test.	Percentage rejected of total number of heats tested.
	Tons.	*Pounds.*	*Per cent.*		*Ft. lbs.*	*Tons.*			*Per cent.*
Chester Rolling Mills	1,616.17	61,987	26.09	1,617,141	9,696	14.73	237	60	20.2
Park. Bro. & Co	287.40	63,125	25.83	1,630,519	9,763	23.93	56	9	13.81
Norway Steel and Iron Co	1,616.22	62,472	25.56	1,596,784	9,581	13.75	308	61	16.53
Cambria Iron Co	1,053.00	64,020	25.52	1,633,790	9,803	3.41	133	16	10.74
Total	4,572.79					55.82	734	146	
Average		62,698	25.755	1,619,560	9,685				16.59

* Efficiency number = ultimate tensile strength × final elongation. See p. 515.
† On a basis of area of strain diagram = 0.9 of efficiency number. See p. 516.

Results for both tensile strength and ductility are necessary t estimate of absolute quality of metal as distinguished from mere ness or softness. Either result may be altered only by correspo alteration of the other in material of given intrinsic quality; a extreme cases, if both be high the steel is good, if both be low th is poor. A single measure of intrinsic quality is available in the mate resilience" or amount of work necessary to produce ruptur piece of standard dimensions. An accurate value of this functio only be obtained from a strain diagram, which denotes the pow resistance of the material, as an indicator-card gives the power of coming resistance for an engine, and is equally a gauge of quality standard conditions. Without automatic apparatus for describing a strain diagram is not to be obtained for each piece, but analysis diagrams made during this inspection (pp. 515 and 516) shows for unannealed material such as we are considering, in no pa larly abnormal physical condition, the area of the strain diagram a pretty constant ratio to the product of its extreme dimension may be taken as not far from 90 per cent. of the product of ultimat sile strength and final elongation. The latter product, therefore, n considered a more or less accurate measure of intrinsic quality for p of standard dimensions, and is called in the table the efficiency nu

While the measured length in all tests was the same (8 inches area and proportion of cross-section varied widely except in tests at the Cambria Iron Works; so that, as the proportion of the test is held to affect the results for ductility, a comparison of the effic numbers in the table cannot be taken as a strict gauge of re quality. The average sectional area of all tests is not far fr square inch, for which dimensions the average efficiency numl seen to be 1,619,560, in pounds per cent. Taking the area of diagram as 90 per cent. of the efficiency number in pounds per and reducing to foot-pounds, we have 9,685 foot-pounds as the av ultimate resilience of a bar of one square inch sectional area 8 i long, the ductility being reckoned on the basis of one-half a s inch of sectional area.

The above value of the efficiency number being for material acce and therefore of good quality, we see that, under these conditio test, the minimum strength required for boiler plate, 57,000 po

l be accompanied by a ductility of 28.4 per cent.; while the ial of the maximum strength allowed, 63,000 pounds, should have er cent. elongation. For ship material, 60,000 pounds should be ipanied by 27 per cent. elongation, while the minimum elongation per cent. should be associated with a tensile strength of 70,400 ls. A good guide in fixing specifications is thus obtained, and argin allowed manufacturers under any given specification can preciated.

purposes of comparison with foreign results or specifications, the ge results may be stated as a tensile strength of 62,698 pounds, tons, per square inch (=44.09 kilograms per square millimeter) ı ductility in 8 inches of 25.755 per cent. on an area of one-half e inch.

STEEL IN THE SHIP-YARD AND BOILER-SHOP.

he total of 4,570 tons delivered, about 4,000 tons had been worked ıull and boilers by September 1, 1884. In the boiler-shops a cer- ımount of experience had already been obtained in treating the ial. Although previously using steel for certain parts of boilers, ntractors, Messrs. John Roach & Son, had commenced construct- oilers entirely of steel (of somewhat softer quality than that for uisers) in 1882, using not far from 1,000 tons each in that and the ear.

he ship-yard the workmen had little or no experience with the ma- Yet the results obtained in point of failures of material under ıent in the ship-yard are particularly good. The bending of frames l joggling were done hot; welding of beam-arms, and in most other , was done with glut-pieces of iron between the steel surfaces, h the staple-angles in the wings of the double bottom were welded to steel. Boss-plates were shaped hot, without accident. But ailures were reported, and of these the cause was evident, as given table.

TABLE X.—*Failures of steel in working up to September* 1, 1884.

ate.	To be employed for—	Treatment when failure occurred.	Cause assigned.	Makers.
r 17, 1883.	Tube-sheet, Atlanta's boilers.	Being chipped hot near punched edge.	....	Chester Rolling Mills.
r 18, 1883.	Boss-frame, Dolphin...	Fairing by hydraulic fairing-machine.	Overheating..	Phœnix Iron Company.
12, 1884..	......do	......do	....do	Do.
31, 1884..	2 shell-plates, Boston's boilers.	Cracked from outer row of rivet-holes to edge of plate.	....	Chester Rolling Mills.
y 23, 1884.	Front head, Boston's boilers.	Cracked from edge while flanging.	....	Do.
, 1884	Back head, Atlanta's boilers.	Cracked from edge after riveting up.	....	Do.
, 1884	2 tube-sheets, Chicago's boilers.	Flanging	Laminations..	Norway Steel and Iron Company.
7, 1884	Back tube-sheet, Chicago's boilers.	......do	....do	Do.
, 1884	3 back tube-sheets, Chicago's boilers.	Developed laminations in flanging.	....do	Do.
, 1884	1 back tube-sheet, Chicago's boilers.	Developed laminations in flanging, and cracked from edge partially flanged.	....	Do.
1884.......	2 superstructure beams, Atlanta and Boston.	Setting knee to shape.	Web cut too deep in removing bulb to fay.	Phœnix Iron Company.

The chief source of trouble was in flanging the boiler-plates, failure frequently occurring from laminations in the edge of the plate. Some of the more or less unaccountable failures after treatment arising from a state of internal strain will be found.

It should be stated that the rivet-holes were punched in the boiler-plates of the Dolphin, Boston, and Atlanta, and drilled in those of the Chicago.

The first failure, reported December 17, 1883, is thus described by the inspector:

"The sheet had been partially flanged and punched for tube-hole cutter-guide; while cutting off a piece, marked A, hot, with a chisel, the sheet split 1½ inches; while cooling the crack extended 4½ inches, and when cold, as the sheet was being hauled over the ground, the crack extended 5 inches farther.

"The number of the sheet had been obliterated. Since the failure of that sheet, seven others have been subjected to the same punching, cutting, and flanging, and no failures have occurred."

A strip 1½ inches wide was sheared from that portion which had been punched out by the lines of holes marked B and C in the diagram; it broke easily on bending, but after heating and quenching in water, it bent double under a sledge without fracture.

From each of the two steel plates of the Boston's boilers reported January 31, 1884, two pieces for tensile test were cut, as near as possible to the rivet-holes, and gave the following average results, with trifling variations for individual pieces: 59,275 pounds tensile strength, with 25.58 per cent. elongation, and a final area of 47.6 per cent.; perfectly consistent and normal, though the efficiency number is not particularly high and considerably lower than for the corresponding heat tests.

The heat test of the sheet reported February 23, 1884, gave 30.84 per cent. elongation, with a final area of 48.5 per cent., being heat No. 582 in the tables of Chester steel.

The total weight of material contained in the table of failures is less than 17,500 pounds, or about 7¾ tons, a very small per cent. of the amount delivered.

STEEL FOR RIVETS.

A built-up structure, such as ship or boiler, depends for strength almost entirely upon the resistance offered at the joints, which resistance, for most conditions of stress, is, or should be, made up equally of the resistances of plate and of rivet. When, in addition, we consider the severe treatment and liability to excessive internal strain to which a rivet is subjected in driving and setting, the necessity for careful selection of material and of quality is very apparent. There are two chief opposing conditions in the selection of rivet-metal, the one the great advantage gained in increased strength of joint by using metal of higher shearing strength with fewer or smaller rivets, the other the brittleness of beads and shanks of rivets developed in hard metal under severe treatment. It is a matter for careful consideration whether the first cannot be obtained in a higher degree than at present without too great development of the second.

The rivets supplied were all of steel made by the Bessemer process chiefly by the Pittsburgh Steel Casting Company, though a few thousand pounds were made by the Burden Iron Company, Troy, N. Y. The steel supplied by the above company was delivered in billets marked with the number of the blow, to the rivet manufacturers, ea

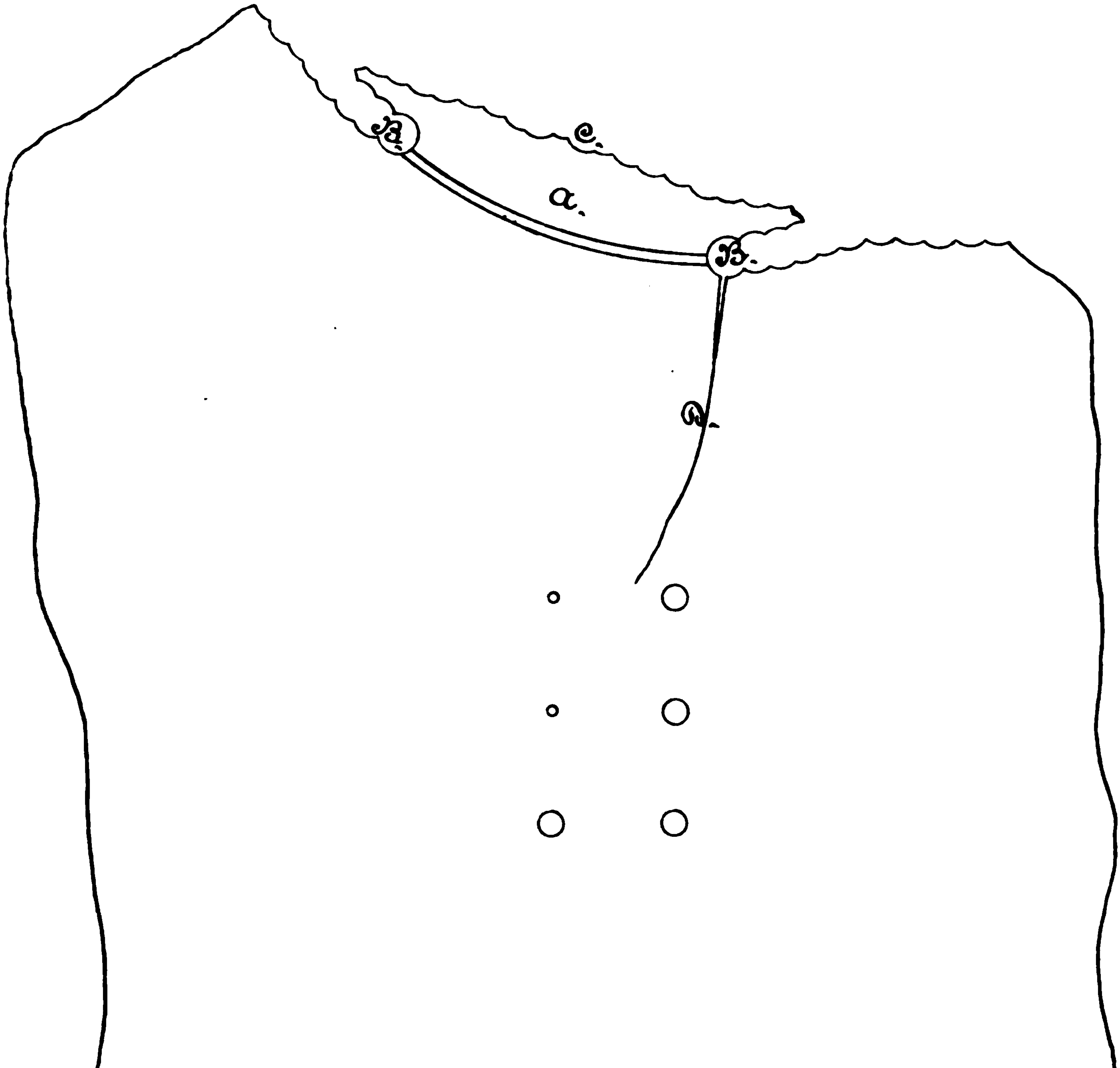


Fig. 9 .- Illustrating failure of tube sheet of "Atlanta's" boilers

TABLE XI.—*Tests of rivets and rivet bars. Chester Rolling Mills.*

Lot No.	Nominal size of rivet.	Tensile tests: Average original diameter.	Average original area.	Average ultimate tensile strength per square inch.	Average final elongation.	Average final area.	Number of tests.	Passed or failed.	Shearing tests: Nominal size of rivet hole.	Average shearing area.	Average ultimate shearing strength per square inch.	Ratio to tensile strength.	Number of tests.	Passed or failed.	Hammer and bending tests passed or failed.	Accepted or rejected.	Manufacturer.	Remarks.
	In.	*Inch.*	*Sq.in.*	*Pounds*	*Perct.*	*Perct.*			*Inch.*	*Sq.in.*	*Pounds*	*Perct.*				*Pounds.*		
9	[illegible]	.693	.3773	60,670	26.78	41.6	4	P.	13/16	1.037	47,495	79.10	10	P.	P.	*7,800	Jones & Laughlin	Double shear.
13	[illegible]	.764	.4584	70,120	24.16	55.7	2	P.	15/16	1.380	56,100	80.00	2	P.	P.	*1,008	do	Double shear; ¾-inch bar turned down.
14	¾	......	......	......	......	......	...	...	13/16	.5185	55,917	......	6	P.	P.	*16,900	do	Single shear.
33	¾	.694	.3782	60,575	26.48	44.2	4	P.	13/16	1.037	44,467	73.64	3	P.	P.	*10,000	Jones & Laughlin and Burden Iron Company.	Do.
									13/16	.5185	46,450	76.94	6	P.	P.			Double shear.
....	¾	.720	.4071	57,263	26.5	41.8	4	F.								†10,000	Jones & Laughlin	
40	⅞	.820	.5281	66,950	27.15	45.0	2	P.	15/16	1.380	52,900	79.02	2	P.	P.	*286	do	Do.
43	⅞	.844	.5592	61,860	30.30	42.8	2	P.	15/16	.6903	54,400	88.03	2	P.	P.	*825	Combination Iron and Steel Works.	Single shear from here on.
46	⅝	.595	.2780	65,890	24.85	39.0	2	P.	11/16	.3712	55,633	84.44	3	P.	P.	*825	do	
47	¾	.702	.3870	63,400	30.79	32.9	2	P.	13/16	.5185	54,900	86.60	3	P.	P.	*2,500	do	
52	¾	.700	.3850	62,650	29.95	32.9	2	P.	13/16	.5185	48,500	77.42	3	P.	P.	*2,000	do	
53	¾	.709	.3960	61,290	27.82	41.4	6	P.	13/16	.5180	55,580	90.68	5	P.	P.	*5,000	Jones & Laughlin	
54	¾	.699	.3847	62,160	27.48	37.3	5	P.	13/16	.5180	49,540	79.70	10	P.	P.	*5,000	Burden Iron Company	
66	¾	.721	.4072	59,000	27.60	30.0	1	P.	13/16	.5180	52,000	88.14	1	P.	P.	*300	Combination Iron and Steel Works.	
	⅝	.593	.2760	63,100	25.07	40.5	3	P.	11/16	.3710	56,140	88.96	5	P.	P.	*2,400		
69	¾	.698	.3829	60,740	27.55	42.0	10	P.	13/16	.5185	54,920	90.42	10	P.	P.	*10,000	do	
110	⅝	.632	.3140	63,012	28.32	43.4	17	P.	11/16 & 13/16	.4277	50,712	80.50	17	P.	P.	*17,500	do	
111	¾	.749	.4402	60,395	30.23	40.9	30	P.	13/16	.5180	52,790	87.42	30	P.	P.	*30,000	do	
112	⅞	.875	.6013	59,830	29.38	42.8	4	P.	15/16	.6900	52,167	87.20	3	P.	P.	*3,700	do	
125	¾	.747	.4383	61,814	27.93	39.7	7	P.	13/16 & 11/16	.3656	56,143	90.84	7	P.	P.	*7,000	do	
128	¾	.748	.4387	62,183	26.17	40.5	6	P.	13/16	.5184	57,714	92.83	7	P.	P.	*8,000	do	
129	¾	.750	.4410	69,600	26.66	43.6	5	P.	13/16 & 11/16	.5350	55,200	79.31	5	P.	P.	*5,000	do	
130	¾	.749	.4402	69,667	27.90	47.7	6	P.	13/16 & 13/16	.5460	57,667	82.78	6	P.	P.	*6,000	do	
137, 138	¾	.744	.4343	70,250	28.30	44.2	8	P.	[illegible]	.5160	53,675	76.41	8	P.	P.	*8,000	do	
145	¾	.746	.4368	61,917	28.75	36.8	6	P.	[illegible]	.5653	53,500	86.42	6	P.	P.	*6,100	do	

	630	3.20	61,700	23 30	49 0	1	P	.4710	54,000	84.78	1	P.	P.	*700	do	
178	760	[illegible]	6[illegible],000	24 [illegible]	40 0	1	P	[illegible]	54 [illegible]00	83 08	2	P.	P	*1,400	do	Do.
	7[illegible]4	[illegible]	[illegible]5,000	[illegible]8	44 [illegible]	3	P	[illegible]	5[illegible] 667	80 21	3	P.	P.	*2,700	do	
179	[illegible]	[illegible]	[illegible]	[illegible]	45 [illegible]	1	P	[illegible]	[illegible]5 000	83 34	1	P	P.	*1,200	do	Do.
181	757	[illegible]	64,000	[illegible]	41 [illegible]	2	P	[illegible]	56 [illegible]	80.83	2	P.	P.	*2,200	do	
	[illegible]	[illegible]	[illegible]	26 [illegible]	[illegible]	[illegible]	P	4000	[illegible]5 300	85.28	3	P.	P.	*1,900	do	
183	[illegible]	[illegible]	[illegible]	27 [illegible]	4[illegible] 0	2	P	[illegible]78	[illegible],300	81 82	2	P.	P.	*1,800	do	
	618	[illegible]	[illegible]	24 [illegible]	4[illegible] 0	2	P	3900	[illegible]	8[illegible] 61	2	P.	P.	*1,000	do	
183	[illegible]	[illegible]	[illegible]	[illegible]	40 0	1	P	[illegible]	[illegible] 500	8[illegible] 58	2	P	P.	*1,400	do	
	[illegible]	[illegible]	[illegible]	2[illegible]	31 7	4	P	[illegible]	54 250	83 46	4	P.	P.	*3,900	do	
184	[illegible]	[illegible]	[illegible]	2[illegible]	[illegible]	3	P	[illegible]	[illegible]	81 65	3	P.	P.	*3,000	do	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	P	4000	[illegible] 000	84 63	1	P.	P.	*500	do	
185	[illegible]	[illegible]	[illegible]	2[illegible]	41 [illegible]		P	[illegible]	[illegible]3,000	80 92	2	P.	P.	*1,600	do	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	P	[illegible]	[illegible]4 000	83 08	1	P	P.	*400	do	
186	[illegible]	[illegible]	[illegible]	[illegible]	44 [illegible]	2	P	4000	57 000	87 70	2	P.	P.	*2,000	do	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		P	[illegible]	55 700	87 03	1	P	P.	*200	do	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4[illegible]	4	P	3725	54,400	84 87	4	P	P.	*4,400	do	
	[illegible]	[illegible]	[illegible]	[illegible]	50 0	4	P	[illegible]	[illegible]	82.12	5	P.	P.	*4,900	do	
147	[illegible]	[illegible]	[illegible]	[illegible]	41 2	2	P	5800	54,500	77 86	2	P.	P.	*2,100	do	
	490	[illegible]	[illegible]	[illegible]	41 0	1	P	[illegible]	56.000	91 80	1	P	P.	*600	do	
	[illegible]	4100	[illegible]	27 [illegible]	42 7	4	P	5184	54 025	82.22	4	P	P.	*7,100	do	
149	625	[illegible]	[illegible]	26 [illegible]	4[illegible] 3	3	P	3800	59,[illegible]00	84 69	3	P.	P.		do	
	500	[illegible]	6[illegible],000	27 [illegible]	36 0	1	P	2465	56 000	93 33	1	P.	P.		do	
	5[illegible]7	[illegible]	65 000	[illegible]4 30	45 0	1	P	6006	5[illegible],000	86 16	1	P.	P.	*8,400	do	Do.
151	750	[illegible]	65,1[illegible]	[illegible]8 20	40 0	5	P	[illegible]	[illegible]0,400	77.43	5	P.	P.		do	
	[illegible]	[illegible]	[illegible]	2[illegible] 47	44 0	3	P	38[illegible]7	59 000	86.36	3	P.	P.		do	
	762	4205	63,000	[illegible]5 00	40.0	1	P	6010	49,000	77 78	1	P.	P.	*700	do	Do
166	750	4417	65 500	28.03	42 7	4	P	.5180	50,000	78.34	1	P.	P.	*1,500	do	
	633	3151	[illegible],330	[illegible].16	42 0	3	P.	3710	54,607	77 74	3	P.	P.	*2,500	do	
	497	.1040	60,000	25 [illegible]	33 0	1	P.	2000	50,000	83.33	1	P.	P.	*500	do	
	737	4596	63,833	28.[illegible]3	40 3	6	P.	.5180	50,620	7[illegible].30	6	P.	P.	*5,900	do	
161	635	3106	62,000	27 73	41 5	2	P	.3710	51 607	83.34	3	P.	P.	*1,700	do	
	498	1947	60 000	23 0[illegible]	30 0	1	P.	.2480	52,000	86.67	1	P.	P	*1,300	do	
162	754	4471	64 700	28.70	41 3	7	P.	.5180	52,250	80.76	8	P.	P.	*7,500	do	
	.620	.3020	64 000	24 00	30.0	1	P	.3710	57,000	89.06	1	P	P.	*900	do	
	.740	4300	5[illegible],600	28 00	41 0	1	P.	.6900	49,300	85.00	1	P.	P.	†800	do	Do.
165	.754	.4469	65,667	27 23	48.7	3	P.	5180	52,667	80.21	3	P.	P.	*3,000	do	
	634	3156	61,250	‡25 00	45.7	4	P.	3710	53,150	86.78	4	P.	P.	‡3,300	do	
167	750	4624	61,200	28.00	47.4	5	P.	.5180	50,600	82.68	5	P	P.	*6,100	do	
	635	3170	61,000	27 00	39.5	2	P.	.3835	53,500	87.70	2	P	P.	*1,400	do	
169	750	.4476	62,222	27.17	46 3	9	P.	.5180	53,125	84 04	8	P.	P.	*7,800	do	
	.635	.3170	61,100	25.50	40.0	2	P.	.4000	55,000	90.02	2	P.	P.	*1,700	do	
192	.630	.3020	64,000	26.00	42.0	2	P.	.4000	56,333	88.02	3	P.	P.	*2,300	do	

* Accepted. † Rejected. ‡ One piece gave 20.7 per cent. elongation.

TABLE XI.—*Tests of rivets and rivet bars. Chester Rolling Mills*—Continued.

Lot No.	Nominal size of rivet.	Tensile tests. Average original diameter.	Tensile tests. Average original area.	Tensile tests. Average ultimate tensile strength per square inch.	Tensile tests. Average final elongation.	Tensile tests. Average final area.	Tensile tests. Number of tests.	Tensile tests. Passed or failed.	Shearing tests. Nominal size of rivet hole.	Shearing tests. Average shearing area.	Shearing tests. Average ultimate shearing strength per square inch.	Shearing tests. Ratio to tensile strength.	Shearing tests. Number of tests.	Shearing tests. Passed or failed.	Hammer and bending tests passed or failed.	Accepted or rejected.	Manufacturer.	Remarks.
	In.	*Inch.*	*Sq.in.*	*Pounds.*	*Perct.*	*Perct.*			*Inch.*	*Sq.in.*	*Pounds.*	*Perct.*				*Pounds.*		
193	7/8	.660	.3415	66,500	25.00	43.0	2	P.	15/16	.6900	52,000	78.20	2	P.	P.	*2,200	Combination Iron and Steel Works.	7/8-inch bar turned down.
	3/4	.750	.4420	67.000	27.00	43.0	1	P.	13/16	.5200	57,000	85.08	1	P.	P.	*500	do	
	5/8	.620	.3020	68,000	25.50	42.0	1	P.	11/16	.4000	55,000	80.90	2	P.	P.	*1,400	do	
134	7/8	.750	.4420	63,000	27.00	43.0	1	P.	15/16	.6600	51,000	80.95	1	P.	P.	*800	do	Do.
	5/8	.620	.3000	67,000	27.00	40.0	1	P.							P.	*200	do	
198	7/8	.700	.3360	66,500	27.40	47.5	2	P.	15/16	.6900	52,000	78.20	2	P.	P.	*1,700	do	Do.
	[illegible]	.625	.3070	65,000	24.00	40.0	1	P.	11/16	.3700	58,000	89.24	1	P.	P.	*600	do	
199	[illegible]	.750	.4400	70,000	27.75	42.8	2	P.	15/16	.7000	52,500	75.00	2	P.	P.	*2,000	do	Do.
	[illegible]	.742	.4327	67,300	28.17	40.7	3	P.	13/16	.5200	56,667	84.21	3	P.	P.	*3,500	do	
	[illegible]	.625	.3070	69,000	27.50	41.0	1	P.	11/16	.3900	59,000	85.52	1	P.	P.	*400	do	
201	[illegible]	.750	.4400	67,333	24.67	42.0	3	P.	15/16	.6933	52,667	78.23	3	P.	P.	*2,700	do	Do.
	[illegible]	.740	.4300	67,800	28.00	43.0	1	P.	13/16	.5200	56,000	82.61	2	P.	P.	*1,300	do	
	[illegible]	.630	.3120	67,000	27.50	40.0	1	P.	11/16	.3800	60,000	89.56	1	P.	P.	*1,200	do	
202	[illegible]	.757	.4500	66,000	24.80	43.6	1	P.	[illegible]	.7000	54,000	81.82	1	P.	P.	*600	do	Do.
	[illegible]	.743	.4333	66,333	25.67	45.6	3	P.	[illegible]	.5200	56,333	84.92	3	P.	P.	*2,300	do	
203	[illegible]	.758	.4506	63,000	23.00	44.0	2	P.	[illegible]	.6950	52,000	82.55	2	P.	P.	*2,000	do	Do.
	[illegible]	.744	.4348	65,500	29.50	39.5	2	P.	[illegible]	.5200	60,000	91.02	2	P.	P.	*1,600	do	
	[illegible]	.625	.2970	70,000	26.00	40.0	1	P.	[illegible]	.3800	58,000	82.86	1	P.	P.	*1,200	do	
204	[illegible]	.758	.4500	68,000	23.00	45.0	1	P.	[illegible]	.7000	54,000	79.42	1	P.	P.	*1,200	do	Do.
	[illegible]	.750	.4400	67,333	25.67	38.3	3	P.	[illegible]	.5200	56,000	83.17	3	P.	P.	*2,600	do	
	[illegible]	.625	.3100	69,000	26.00	38.0	1	P.	[illegible]	.3700	59,000	85.50	1	P.	P.	*300	do	
205	[illegible]	.745	.4350	64,300	27.90	45.0	2	P.	[illegible]	.5200	55,500	86.32	2	P.	P.	*2,100	do	
	[illegible]	.625	.3070	64,500	26.60	40.0	2	P.	[illegible]	.3700	59,000	91.48	2	P.	P.	*1,400	do	
208	[illegible]	.620	.3019	65,200	24.95	43.3	2	P.	[illegible]	.3750	56,000	85.90	2	P.	P.	*2,000	do	
218	[illegible]	.750	.4417	64,000	26.00	41.0	1	P.	[illegible]	.6900	53,000	82.81	1	P.	P.	*700	do	Do.
	[illegible]	.744	.4350	64,500	27.90	40.5	2	P.	[illegible]	.5180	55,500	86.06	2	P.	P.	*2,200	do	
	[illegible]	.629	.3113	68,000	28.33	43.7	3	P.	[illegible]	.3800	54,667	80.40	3	P.	P.	*2,700	do	
219	[illegible]	.748	.4390	63,700	25.00	40.0	1	P.	[illegible]	.6900	52,000	81.64	1	P.	P.	*1,500	do	Do.
	[illegible]	.740	.4300	66,000	27.00	43.0	1	P.	[illegible]	.5200	55,000	83.34	1	P.	P.	*400	do	
	[illegible]	.621	.3032	65,800	27.04	38.6	5	P.	[illegible]	.3700	55,600	84.51	5	P.	P.	*4,500	do	
220	[illegible]	.721	.4083	65,500	27.60	41.0	2	P.	[illegible]	.6900	54,000	82.45	2	P.	P.	*2,500	do	Do.
	[illegible]	.622	.3043	64,500	25.80	38.0	3	P.	[illegible]	.3710	56,000	86.82	3	P.	P.	*1,500	do	

* Accepted.

General summary.

ACCEPTED RIVETS

Nominal size of rivet.	Average ultimate tensile strength per square inch	Average final elongation	Average final area.	Number of tests.	Average ultimate shearing strength per square inch	Number of tests.	Ratio to tensile strength.	Accepted
Inch.	*Pounds.*	*Per ct.*	*Per ct.*		*Pounds*		*Per ct*	*Pounds*
[illegible]	65,200	26.35	43.62	34	52,980	34	81.27	29,119
[illegible]	64,900	28.12	42.35	183	53,260	206	82.08	204,000
[illegible]	64,552	26.58	41.88	101	54,758	107	84.84	98,925
[illegible]	60,929	26.01	36.71	7	53,430	7	87.69	4,200
All	64,740	27.41	42.00	325	53,695	354	82.94	331,244

TABLE XII.—*Tests of rivets and rivet bars, Pittsburgh, Pa.*

Lot No.	Nominal size of rivet.	Tensile tests. Average original diameter.	Average original area.	Average ultimate tensile strength per square inch.	Average final elongation.	Average final area.	Number of tests.	Passed or failed.	Shearing tests. Nominal size of rivet hole.	Shearing area.	Ultimate shearing strength per square inch.	Ratio to tensile strength.	Number of tests.	Passed or failed.	Hammer tests, passed or failed.	Accepted or rejected.	Manufacturer	Remarks.
	In.	*Inch.*	*Sq. in.*	*Pounds.*	*Per ct.*	*Per ct.*			*Inch.*	*Sq. in.*	*Pounds.*	*Per ct.*				*Pounds.*		
1	¾	.741	.4305	62,055	27.36	43.10	2	P.	13/16	.5150	51,510	81.[illegible]	1	P.	P.	*1,000	Jones & Laughlin	ingle
2	¾	.745	.4350	61,370	27.25	38.97	2	P.	"	.5150	52,000	84.73	1	P.	P.	*1,000	do	Do.
3	¾	.743	.4330	62,695	29.06	37.53	2	P.	"	.5150	52,000	82.94	1	P.	P.	*1,000	do	Do.
4	¾	.744	.4350	62,640	29.19	37.35	2	P.	"	.5150	51,030	81.47	1	P.	P.	*1,000	do	Do.
5	¾	.741	.4305	61,065	28.13	38.55	2	P.	"	.5150	51,750	84.72	1	P.	P.	*1,000	do	Do.
6	¾	.741	.4310	61,710	27.44	38.51	2	P.	"	.5150	53,700	87.02	1	P.	P.	*1,000	do	Do.
7	¾	.744	.4335	60,780	28.44	44.41	2	P.	"	.5150	52,970	87.15	1	P.	P.	*1,000	do	Do.
8	¾	.735	.4205	61,665	28.25	44.06	2	P.	"	.5150	50,060	81.20	1	P.	P.	*1,000	do	Do.
9	¾	.745	.4350	63,445	27.50	38.17	2	P.	"	.5150	52,970	83.48	1	P.	P.	*1,000	do	Do.
10	¾	.743	.4330	61,090	28.81	41.01	2	P.	"	.5150	53,940	88.20	1	P.	P.	*1,000	do	Do.
11	¾	.730	.4280	62,905	27.81	38.76	2	P.	"	.5150	53,450	84.89	1	P.	P.	*1,000	do	Do.
12	¾	.718	.4035	66,055	28.63	37.60	2	P.	"	.5150	52,000	78.72	1	P.	P.	*1,000	do	Do.
13	¾	.730	.4180	64,090	27.75	37.16	2	P.	"	.5150	53,450	83.40	1	P.	P.	*1,000	do	Do.
14	¾	.728	.4150	63,025	29.06	38.25	2	P.	"	.5150	50,060	78.81	1	P.	P.	*800	do	Do.
15	¾	.731	.4190	63,220	28.93	37.05	2	P.	"	.5150	50,080	79.04	1	P.	P.	*1,000	do	Do.
16	¾	.744	.4340	62,290	28.13	44.45	2	P.	"	.5150	50,000	80.38	1	P.	P.	*1,000	do	Do.
17	¾	.744	.4340	61,135	29.50	39.00	2	P.	"	.5150	50,080	81.88	1	P.	P.	*1,000	do	Do.
18	¾	.748	.4385	62,210	28.67	43.11	2	P.	"	.5150	51,080	82.03	1	P.	P.	*1,000	do	Do.
19	¾	.746	.4365	60,490	29.87	36.96	2	P.	"	.5150	52,500	85.97	1	P.	P.	*1,000	do	Do.
20	¾	.746	.4365	62,820	29.81	41.40	2	P.	"	.5150	50,540	79.81	1	P.	P.	*500	do	Do.
All	¾	.740	.4290	62,462	28.47	39.77	40	P.	"	.5150	51,732	82.89	20	P.	P.	*19,300		

*A.

Table XII. gives the results of tests on ¾-inch rivets supplied by nes & Laughlin, and tested at Pittsburgh by the inspector there. machine used was that of Park, Bro. & Co. The results agree n with those obtained from similar metal at Chester. The inspec- n at Pittsburgh was discontinued as a matter of convenience, the being subsequently all made at Chester.

STEEL FORGINGS.

Steel shafts have been the subject of special investigation and ex- riments not yet completed by the Board, and upon which report been made to the Department. Apart from this class of forgings, stems, stern-posts, and rudder frames of the vessels are of steel, ged either from scrap or bloom. By forgings from bloom is not ant from a solid piece of metal, but from a number of billets or oms of convenient size; as they have not so many reheatings as a ap forging their average quality is better.

Table XIII. contains the record of the physical tests of the larger gings from scrap and bloom. While the scrap forgings do not give high average strength or elongation as those from the blooms, they t give very fair results, and considerably better than is to be expected m wrought iron similarly treated. The average results in the table ow the forging from bloom to be about 15 per cent. better metal than at from scrap.

TABLE XIII.

Forging.	Forged from—	Original width.	Original thickness.	Original area.	Ultimate tensile strength, per square inch.	Final elongation in 8 inches.	Final area.
		Inch.	Inch.	Sq. inch.	Pounds.	Per ct.	Per ct.
m and stern-post	Scrap	.748	.748	.5595	57,100	18.70	42.8
		.750	.740	.5550	55,830	17.30	41.5
		.764	.738	.5638	54,100	18.25	41.3
		.756	.738	.5557	54,000	18.70	42.8
Do	Bloom	.750	.750	.5625	60,100	21.00	36.0
		.766	.745	.5707	58,000	24.65	40.0
		.753	.735	.5534	58,700	23.40	34.0
		.765	.742	.5676	57,500	20.30	37.3
Do	Scrap	.740	.738	.5461	67,000	18.00	*63.0
		.740	.737	.5453	70,000	24.40	42.0
		.737	.737	.5431	66,800	23.30	44.0
		.741	.741	.5490	65,500	20.70	40.0
Do	Bloom	.744	.736	.5475	67,000	22.00	40.0
		.738	.738	.5446	67,000	22.70	39.0
		.745	.741	.5510	68,000	22.80	41.0
		.745	.741	.5483	68,000	20.10	40.0
dder frames—Boston and Atlanta	Scrap	.750	.750	.5625	58,666	23.90	55.0
		.567	.550	.3120	58,680	24.30	35.0
Average	Scrap				60,768	19.75	44.74
Do	Bloom				63,037	22.12	38.41

* Piece defective, showing lamination on fracture.

Many smaller forgings from steel blooms or bars have been used in construction of the machinery for all four vessels. It may be inter- ing to state these parts in detail, as follows:

STEEL PARTS IN THE MACHINERY OF THE DOLPHIN.

hearth steel supplied by the Nashua Steel Company, Nashua, N. H.— necting rods, caps, and bolts; piston rods, caps, and bolts; crank- pillow-block caps, and bolts; coupling bolts and cross-keys of ting; eccentric rods of main steam and cut-off valves; link , connecting bolts, and link blocks of main steam valve gear;

reversing shaft and pins on arms of shaft; keys for securing condenser brackets to the condenser for support of engine cylinders.

STEEL PARTS IN THE MACHINERY OF THE BOSTON AND ATLANTA.

Crucible steel.—Main and cut-off valve stems; bolts for adjusting crank-shaft brasses; all set screws.

Open hearth mild steel, from Nashua, N. H.—Piston rods; main valve rock shafts; high pressure side rods; connecting rod bolts; crank-pins; radial faces of lugs on one disk of clutch-coupling; friction band; gibs and keys, and feathers; coupling bolts; wedges for crank-shaft pillow-blocks.

Cast steel from Chester, Pa.—Pinion on steam turning engine.

Cast steel from Spuyten Duyvil, N. Y.—Cross-heads of air and circulating pump rods.

STEEL PARTS IN THE MACHINERY OF THE CHICAGO.

Mild open hearth steel, from Nashua, N. H.—Bodies of main connecting rods, with their bolts, nuts, and keys; beam center and end pins; crank-shafts and crank-pins; piston rods: main cross-heads; loose couplings of main shafts; cross-heads of main and cut-off valves; gibs and keys of front links; binders of main crank-shafts, with bolts and nuts; bolts and keys of main shaft couplings; rock shafts for main and cut-off valve gear; reversing shaft and binders; main and cut-off rock shaft arms; rock shaft binders and bolts; Stevenson links and blocks; eccentric rods; straps, gibs, and keys for eccentric rods and cut-off rods; bolts securing the beam pillow-blocks to condensers; binders and bolts of beam pillow-blocks.

Crucible steel.—Rods connecting cut-off rock shafts with beam-center pins; valve stems; all set screws.

OPINIONS OF INSPECTORS AS TO DESIRABLE CHANGES IN THE REQUIREMENTS AND SYSTEM OF TESTS.

Before the officers engaged in the inspection of material at the mills and its subsequent working into hulls and boilers should have been detached and ordered to other duty, and in view of the possible action of Congress as to further steel construction for the Navy, the following letter was issued to all inspectors.

NAVAL ADVISORY BOARD, NAVY DEPARTMENT,
Washington City, April 24, 1884.

INSPECTOR OF MATERIAL:

SIR: It is the intention of the Board to compile a new circular for "Tests of steel for cruisers," in which the limits of strength and ductility must be adhered to as required by existing law.

You will please give the matter your careful consideration, and report to the Board on or before June 1, 1884, what changes in the present tests as altered by existing orders, and what additional tests, regulations, or restrictions, you consider desirable as suggested by your present duties.

You will please present your suggestions in a concise form ready to be introduced in the circular, and will state your reasons therefor briefly and concisely, and where necessary quote facts and figures from your reports.

Very respectfully,

E. SIMPSON,
Rear-Admiral, U. S. N., President of the Board.

Lieut. F. J. DRAKE, U. S. N.
Chief Engineer B. B. H. WHARTON, U. S. N.
Chief Engineer ISAAC R. MCNARY, U. S. N.
Assistant Engineer B. C. BRYAN, U. S. N.
Chief Engineer A. W. MORLEY, U. S. N.
Assistant Naval Constructor J. F. HANSCOM, U. S. N.
Assistant Naval Constructor J. B. HOOVER, U. S. N.
Assistant Naval Constructor R. GATEWOOD, U. S. N.
Lieut. G. A. BICKNELL, U. S. N.

By the replies which follow the Board has been largely guided in its ecommendations as embodied in the proposed new circular of "Tests f steel for cruisers." It will be noticed that the changes proposed by he inspectors are, in the main, either in the details of inspection or in he addition of working tests for boiler metal. The few proposed addiional requirements for quality as determined by tensile tests are on omewhat debatable ground, and it is believed would result in appreiable increased cost without proportionate improvement of quality.

[Naval Advisory Board, Office of Inspector of Material, Norway Iron and Steel Company.]

SOUTH BOSTON, MASS., *May* 28, 1884.

SIR: In compliance with your letter of the 24th ultimo, relative to a new circular r "Tests of steel for cruisers," I would respectfully submit the following.

I am, sir, very respectfully, your obedient servant,

F. J. DRAKE,
Lieutenant, Inspector of Material.

Rear-Admiral E. SIMPSON, U. S. N.,
President Naval Advisory Board.

(1) To be inserted after the words "ship plates," in article III., in lieu of "in every of 20, &c., * * * shaped according to the annexed sketch."

"*Conditions of tests.*—All material shall be tested by heats, as follows:

"A *specimen bloom* of not less than 600 pounds weight, shall be selected at random from ch heat, to be cut from the upper third of the ingot. This bloom to be rolled into a ate of 20 pounds to the square foot. Eight test pieces shall be cut from it and shaped cording to the annexed sketch—four for tensile stress and four for the heat-quenchg test, the four latter, after heating to a cherry red, to be plunged in water at a temrature of 80°F. Thus prepared, it must be possible to bend the pieces under a press hammer so that they shall be doubled, with faces touching throughout, without esenting any traces of cracking. These test pieces to have the sharpness of the ter edges of *one sheared side only* taken off with a fine file."

(2) To be inserted in paragraph under "Conditions of acceptance," after the words original section," so as to read, "with a measured elongation in 8 inches of 18 per nt. at the point of failure, and a final elongation of not less than 23 per cent."

(3) To be inserted in lieu of article under "Cases of failure."

"If the average of these four test pieces, numbered 1, 2, 3, 4 (called test I.), falls bew either of the required limits, the *ingot* from which the specimen bloom for pieces 2, 3, 4 was cut *shall be rejected*, and test II. made, consisting of pieces 5 and 6, cut m the lower third of a second ingot of the same heat. If the mean of the results of ese two falls below either of the above limits the entire heat shall be rejected.

"If it be successful, test III., or the mean of pieces 7 and 8, cut from the lower third second ingot, shall decide.

"If in any of tests I., II., III., any single piece shows a tensile stress less than 58,000 unds, or an elongation of less than 18 per cent. at point of failure, or a final elongao of less than 23 per cent., the ingot from which it was cut shall be rejected and e test considered to have failed, regardless of its average."

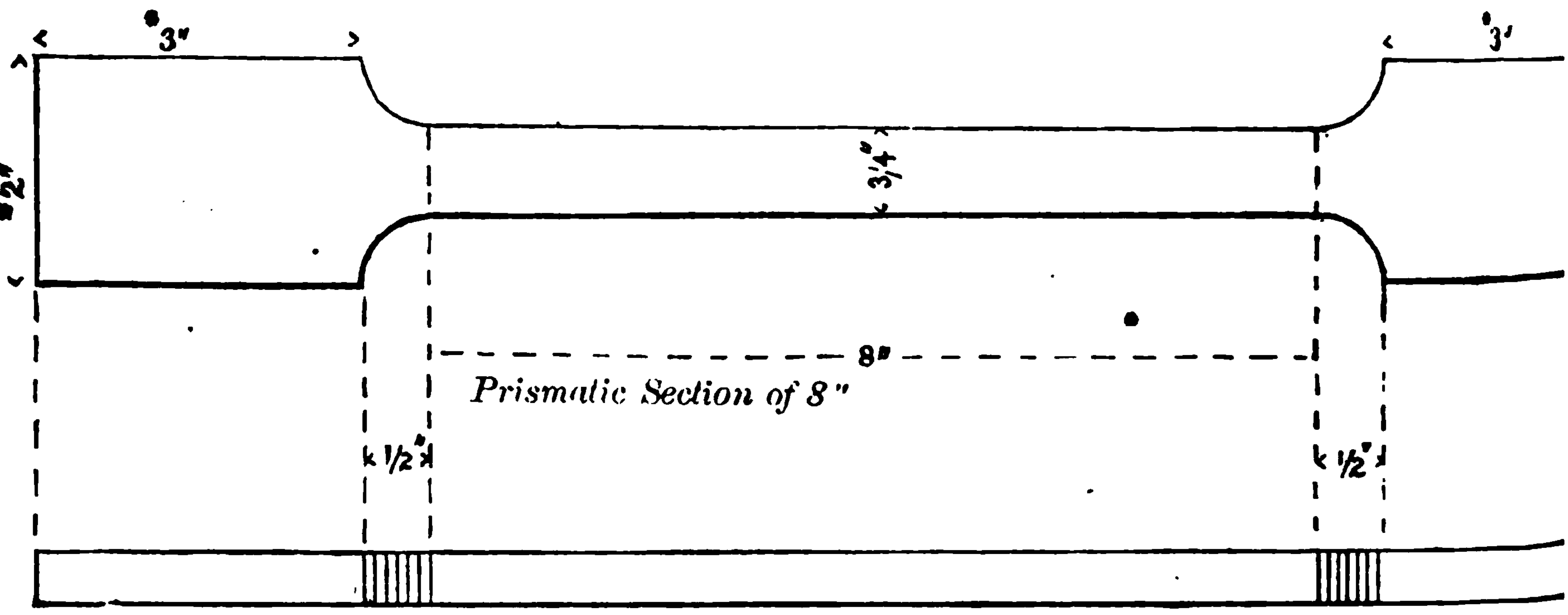
(4) To be inserted in lieu of Article VII.:

"*Boiler plates.*—Each heat for boiler plate must be subjected to the same tests and the manner prescribed for ship plates. In each test piece the ductility in 8 ches at the point of failure must not be less than 20 per cent., and its final elongan not less than 25 per cent., and the ultimate tensile strength must not be less than 000 pounds and not more than 63,000 pounds, and the average of the tests at least ar 60,000 pounds."

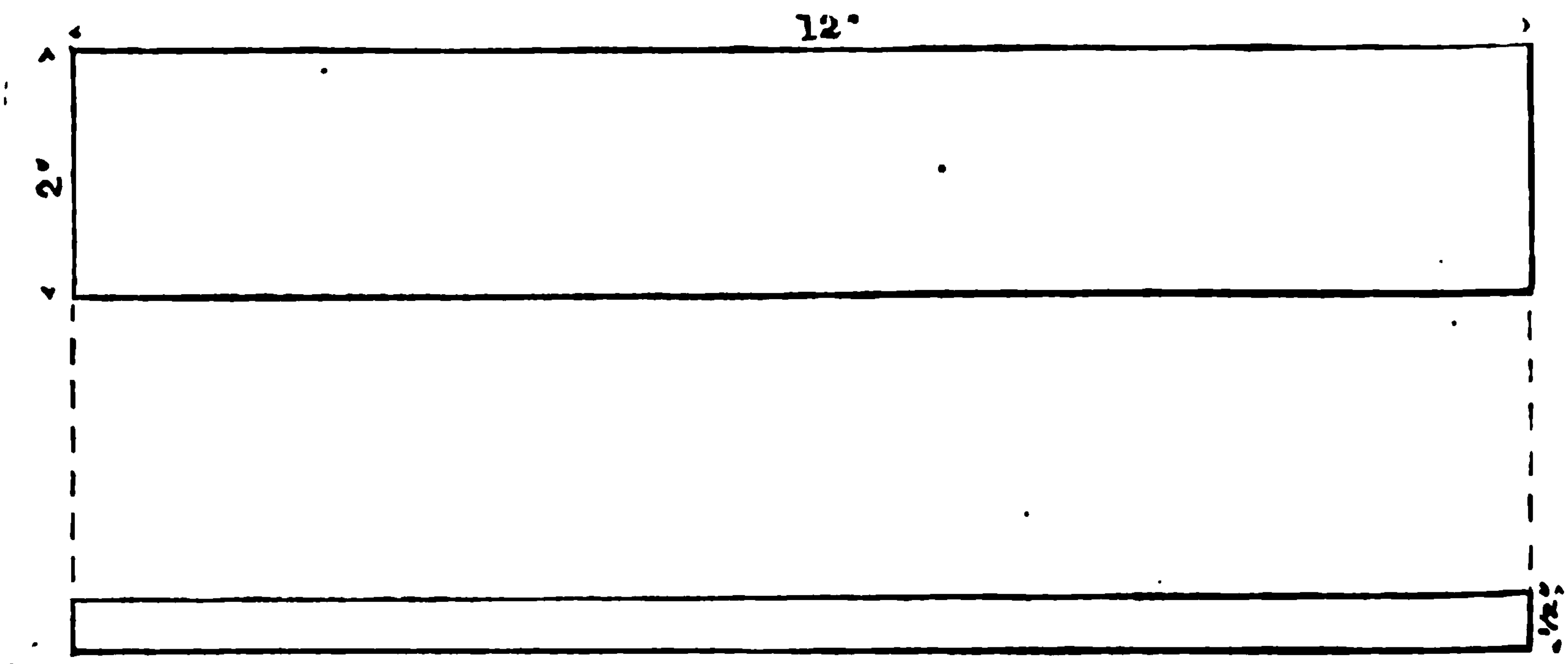
The above suggestions are based on facts, as determined by observation from the lowing heats, which have been accepted. If necessary, more can be quoted to susn the average already given.

Sketch of test pieces.

Scale: ½ full size.

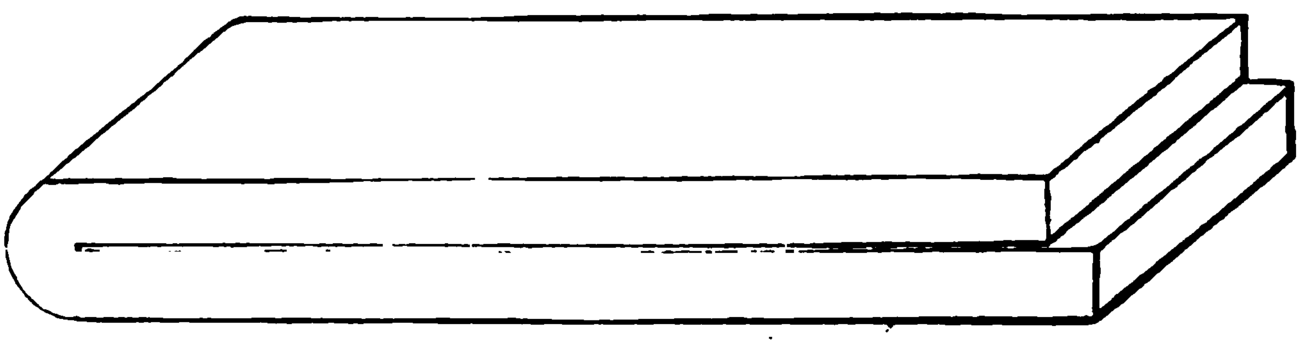


For the test machine.



For the quenching test.

[The figures marked thus * may be varied to suit the size of test machine.]



Heat-quenching test. To bend double, **faces touching.**

[N]umber of heat.	Mean tensile strength of 4 test pieces.	Final elongation in original length of 8 inches.	Elongation at point of failure.	Analysis of—	
				Carbon.	Manganese.
	Pounds.	*Per cent.*	*Per cent.*		
....	60,090	27.25	21.00	13	38
....	62,000	25.50	18.25	22	30
....	60,600	26.75	20.75	17	23
....	61,300	26.75	21.00	16	38
....	60,800	28.25	22.00	16	31
....	60,600	27.00	20.25	18	33
....	60,300	26.50	20.00	15	26
....	61,800	26.75	19.75	15	32
....	62,200	26.25	20.00	17	46
....	61,800	25.75	18.00	18	39
....	62,900	27.75	21.75	15	39
....	60,680	26.75	19.50	15	27
....	63,300	25.75	19.00	18	46
....	62,400	26.00	20.50	19	49
....	62,800	26.00	20.00	19	43
....	61,600	27.50	21.00	17	47
....	60,840	29.75	22.75	14	40
....	61,400	27.00	20.25	15	31
....	60,700	28.00	21.00	14	40
....	60,900	27.00	19.50	20	40
....	60,600	26.00	20.00	18	29
....	61,900	26.50	19.50	18	47
....	60,400	26.25	20.50	15	34
....	60,090	26.75	19.50	18	49
....	60,400	25.25	23.00	13	38
....	60,880	27.50	23.50	18	43
....	62,070	26.75	21.50	18	39
....	60,860	26.50	20.25	19	50
....	60,230	29.88	24.00	19	45
....	62,500	26.75	21.50	23	48
[Ave]rage	61,298	26.81	20.65	17	39

120 test pieces in the above given heats, only seven fall below 60,000 pounds, s:

	Pounds.
39, one test piece	59.966
66, one test piece	59,950
67, one test piece	59,826
325, one test piece	59,796
390, one test piece	59,904
390, one test piece	58,900
452, one test piece	59,625

t consider the present crude system of annealing plates of any value what- I find from observations in testing that it does not improve the average n or lessen the average tensile stress.

m, sir, very respectfully, your obedient servant,

F. J. DRAKE,
Lieutenant, Inspector of Material.

dmiral E. SIMPSON, U. S. N.,
President Naval Advisory Board.

Naval Advisory Board, Office of Inspector of Material, at Chester Rolling Mills.]

CHESTER ROLLING MILLS, *May* 27, 1884.

accordance with the Board's letter of April 24, 1884, I recommend the follow- s:

_e paragraph headed "In cases of failure," substitute 22 per cent. for 21

paragraph IV., headed "Quenching test," add "one piece from each plate be bent cold."

Paragraph VI., "Rivets," should read thus:

1,000 pounds of rivets from the same heat of metal shall constitute a lot, companied by two sample bars, each 18 inches long, for tensile test. These or tensile test shall be cut from the bars from which the lot of rivets is d be stamped with a number, which shall also be placed on each box or of that lot.

samples to be subject to the same tensile test as that required for the plate

"The lot of rivets of which the sample bar does not fulfill the requirements of tensile strength and elongation required for plates is to be rejected.

"From each lot six rivets are to be taken at random and submitted to the following tests, two rivets to be used for each test:

"(1) Two rivets to be flattened out cold under the hammer to a thickness of one-half the diameter without showing cracks or flaws.

"(2) Two rivets to be flattened out hot under the hammer to a thickness of one-third the diameter without showing cracks or flaws.

"(3) Two rivets to be bent cold into the form of a hook with parallel sides without showing cracks or flaws."

REASONS.

Since the present inspection by heats or test plates from a sample ingot began, 262 heats have been inspected, and 42 heats have failed to meet the specifications. Of 150 heats ship, about 13 per cent. have failed; average of tests of tenacity 63,000; ductility 25.5. Of 70 heats boiler, the average of tests is—tenacity, 58,000; ductility, 27.5.

The fact that the average of this ship plate shows 25 per cent. ductility, and the proportion of failures is so small, shows that 23 per cent. is an easy standard to meet, and I think justifies the substitution of 22 per cent. for 21 per cent. in paragraph headed "In cases of failures," in the first change recommended.

Again, as originally required, one of the test pieces was to be cut transversely, and the ductility of such pieces is generally much less than those with the grain. To allow or direct the tests to be all longitudinal and leave the 21 per cent. as it was when half of the tests were across the grain is virtually to allow a metal of less ductility to be accepted. The result is that metal can pass which under the original wording could not pass.

I do not know that any advantages are gained by testing across the grain. But testing as is the practice here, I think each heat should be rejected whenever any piece shows less that 22 per cent. ductility.

In assigning a reason for the change II. it seems sufficient to notice that this test has been retained by the British Admiralty after a by no means inconsiderable experience, and I see no good reason why it should not be used for our metal. The failures of the plate to pass the quenching test here have amounted to less than 2 per cent.

Change III. is simply an attempt to indicate that the rivets in lots of 1,000 pounds should be accompanied by samples for tensile test of the bars from which the rivets are made. Selecting one bar from each twenty gives a varying ratio of amount of inspection for each size of rivet, while 1,000 pounds gives a definite one. The other change increases the hammer test from what is *now*, but not above what *was*, originally prescribed.

The fact is sufficiently well known that steel rivets riveted with ordinary care will shear according to their tensile strength in a similar way throughout. I consider the shearing test unnecessary.

Respectfully,

GEORGE A. BICKNELL,
Lieutenant, U. S. N., Inpector of Material.

Rear-Admiral EDWARD SIMPSON, U. S. N.,
President of the Naval Advisory Board, Navy Department, Washington.

[Naval Advisory Board, Office of Inspector of Material.]

PHŒNIXVILLE, *May* 26, 1884.

SIR: In reply to the Board's communication of the 24th April, relating to modifications of the existing test requirements for mild steel, I have the honor to state that, after careful consideration, I see no reason for any modification of the present requirements, which seem to cover the case completely, as regards material to be manufactured by parties unknown to the Board. Any concessions or simplifications should depend entirely on individual circumstances. Thus, if the shapes for additional vessels were to be made of Cambria open-hearth steel, rolled at the Phœnix Iron Works, there are certain changes which might be made with advantage, which would simplify the work and furnish more complete chemical information. These, however, should be made by arrangement, and should not take the form of the successive removal of particular tests from the requirements, but by substitution of an alternate system acceptable to all parties. For a general circular, I consider the present system simple and effective.

Without desiring to enter upon the general subject of the requirements of the law, as bearing on the quality of the material, I beg to suggest that a somewhat harder steel should be used for all shapes, whether for connecting or stiffening purposes, to be accompanied by a clause in the ship specifications requiring the use of improved

nes and shear-knives, a course now being adopted voluntarily in certain bridge s. In all cases, the upper limit of tensile strength should be imposed, both for es and plates, from considerations of elasticity; for, as will be seen from the reports sile tests, increased tensile strength is accompanied by a rapidly increasing value e modulus of elasticity,* which may, in particular cases, be further affected by aratively cold rolling. This consideration is much less important for shapes for plates, because shapes cannot be rolled below a certain temperature without is danger to the rolls, and they anneal much more in cooling

gles for water-tight work, and beams or frames behind armor or supporting a ctive deck, form exceptions to the above considerations and should be made of rial not harder than the plates they connect or support.

ave ventured to offer the above suggestions as being in the direction of increased ency of the hull and further reduction of scantling, especially in the plating, backed by the stiffer frames and more rigidly connected at the angles, and seeing all that this material will stand when tested to destruction.

ave the honor to further suggest that requirements for quality be issued for iron used. Thus, certain iron angles made here for the boilers of the Dolphin did ome under inspection. * * *

Very respectfully, your obedient servant,

R. GATEWOOD,
Assistant Naval Constructor, U. S. N.

r-Admiral E. SIMPSON, U. S. N.,
President Naval Advisory Board.

[Morgan Iron Works.]

NEW YORK, *May* 29, 1884.

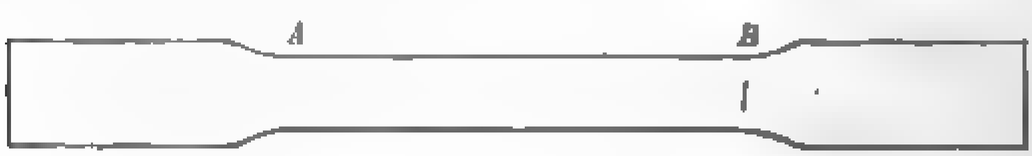
: In obedience to your order of April 24, I have carefully considered the matter te of steel for cruisers, and have the honor to submit the following changes, as taught me as desirable by my recent experience in testing steel. I also include asons for advocating such changes, and a list of articles with which I think each ctor should be provided:

I.—TENSILE TESTS.

Ship plates.—From each of two plates from each heat of steel, two test pieces be cut, one from each end of the plate, one with and one at 90° to direction of g.

Boiler plates.—From each end of each plate to be used for boilers, one test piece be cut, one piece being with and the other at 90° to the direction of rolling.

Angles, beams, channels, &c.—From each heat of steel made for angles, beams, &c., ingot shall be cast, or a "billet" cut when ingot is bloomed. From this ingot let a plate may be rolled and test pieces cut therefrom; or square or round bars e rolled and used for test pieces. Provided, always, that the steel in test pieces receive no more working than the finished material from the heat would have.



Form of test pieces.—The test pieces for all plates shall be of the form shown in . The length, A B, must be sufficient to give 8 inches with parallel sides, and sufficient material cut out to insure the piece from breaking in the grips. The of piece must be sufficient to give between A and B an area of cross-section not han ½ or greater than square inch

en plates are rolled from test ingots or billets for angles, &c., the test pieces conform to this pattern, but need only be cut in direction of rolling. If squares ed the side shall not exceed ⅝ inch. If rounds are used the diameter shall not

his conclusion must have been deduced from only a few heats, as the average modulus of elasticity with increasing strength for this steel is very small. B.

exceed ⅞ inch; in all cases specimens to be long enough to measure elongation in 8 inches.

(5) *Requirements.*—Each test piece shall be submitted to direct tensile stress until it breaks, and in a machine of approved design. The initial stress to be 35,000 pounds per square inch. The first load to be kept in continuous action for one minute. "Additional loads, &c." (see Section III., Tests of Steel for Cruisers, June 18, 1883,) down to "Conditions of Acceptance." At end of first paragraph under "Conditions of Acceptance" add. "and elastic limit not less than 38,000 pounds per square inch. Cases of Failure: If the average of the four test pieces falls below any of the required limits the heat shall be rejected. In the case of boiler plates, if the average of the two pieces from a plate falls below any limit, the plates shall be rejected. If any single piece shows a tensile strength less than 58,000 pounds or a final elongation less than 21 per cent., the heat from which it came (or, in case of boiler plate, the plate from which it came) shall be rejected, regardless of its average."

II.—QUENCHING TEST.

See Section IV. of "Tests of Steel for Cruisers," June 18, 1884, after the words "without presenting any trace of cracking" insert the following: "Piece to be bent until it breaks or bends double, and fracture of break to be examined. If fracture is crystalized and not fibrous, another piece shall be treated in the same way, and if fracture is similar the inspector may reject the plate, bar, angle, &c., from which it was cut."

III.—STAMPING AND ROLLING TEST PIECES.

A list of all ingots made from each heat for angles or beams, &c., must be furnished the inspector. Each ingot shall be stamped in his presence, with the number of the heat. He shall also see the test billet cut off, stamped, and rolled, and must stamp each plate or bar rolled from it, with a private stamp, in such a way that each test piece will have impression of stamp near one end.

Reasons.

I respectfully state that my reasons for advocating these changes are as follows:

For change in tensile test of ship plates, it reduces the number of pieces.

I have found that the difference caused in tensile strength by rolling at a full red or dull red heat is very marked.

I would call attention to the following heats made at Cambria Iron Works, Johnstown, Pa., for cruiser steel:

Number of heat.	Rolled at bright red heat.		Rolled at dull red.	
	Tensile strength.	Elongation.	Tensile strength.	Elongation.
	Pounds.	*Per cent.*	*Pounds.*	*Per cent.*
4452	70,345	25.9	70,573	22.4
4712	69,942	24.3	71,954	22.6
4951	63,135	24.9	64,060	22.8
4478	59,190	28.3	61,590	24.5

A difference is shown here of 2,400 pounds in ultimate strength and 3.8 per cent. elongation, when the difference in heating could scarcely be noticed by any one unaccustomed to heating or working steel. There would, according to this, be a difference in strength and elongation at different parts of a plate if it was not all rolled at a uniform heat. This is found to be true, though when such differences are large they may more properly be attributed to localization of carbon or other elements. In either case, the steel might do for angles and beams or even ship plates; but in boiler plates, where the failure of one sheet is almost sure to cause loss of life and serious damage, every plate should be tested. I have recommended, therefore, a piece to be cut from each end of each boiler plate, and tests for ship plates to come, one for each end of plates from which test pieces are cut. This would detect both the difference made by hot and cold rolling, and also the difference made by unequal diffusion.

I would also require, in specifications for boilers, that every boiler plate flanged,

›d, or heated locally must be annealed after such flanging, &c., has been done. required by Bureau Veritas, and Lloyd's rules.

form of test piece is slightly changed to save labor. From a large number of ›ces, often over two hundred per day, broken in the testing room of Cambria ompany, I had occasion to observe that plain flat pieces, without any slotting n grip ends, very seldom broke in the grips, which was also the case with and square bars, sheared from rolled length without any further work on The original form of test piece, prescribed by the Board, requires a great o be slotted or planed off from grip ends; to save labor, I recommend that ıfficient be taken off to insure the piece from breaking in grips. I also found ıe use of round or square bars would have saved much labor and expense to ›nufacturers of the steel.

area of cross-section is limited in each case because experience has shown m easuring elongation for the same length in all cases, the pieces having the ıt area will give greatest elongation. This has also been found the case and ı on by M. J. Barba in "Memoires de la Societé des Ingénieurs Civils" (*vide* anics," No. 117, March 29, 1884). M. Barba found as the result of many exper- :

Ratio length of piece to diameter.	Elongation.
	Per cent.
2.51	44.5
3.75	37.5
10.00	28.5

›se results are given as those of round bar-steel, but in the case of bars and a corresponding result is obtained."

ve therefore put a limit on the size of the area, since the elongation is to be ›ed always for 8 inches.

initial stress is recommended to be 35,000 pounds per square inch, as this is ounds below the lowest acceptable elastic limit, and experience has shown me calculating the modulus of elasticity for elongations, the results begin to vary ›pidly on approaching the elastic limit of low steel. Thirty-five thousand ı per square inch seems to give very good results, for which I call attention to orts of tests of steel at Johnstown, Pa., October, 1883, to April, 1884. The con- on of first strain is recommended to be one instead of five minutes, to save and this is an important item where, as at Cambria Works, the machine is in ıous use, and many pieces are to be tested.

also recommended to make elastic limit of 38,000 pounds to the square inch a ›ment. I think a higher limit with same elongation preferable, but this is sug- to call the attention of the Board that steel can be made with a low elastic ıot much better, if any, than good iron, and with sufficient strength and elon- to pass specifications.

recommended that the inspector be given power to inspect the fracture of a ıing test piece and reject the steel if the fracture is not in his opinion suffi- good. This is recommended because I have found in quenching pieces a good 'rom poor heats which bent to requirements of specifications and broke just of them and I had not power from specifications to reject the heat. A retest is d to be sure that the test piece itself was not burned in heating for quenching. ırd to the system of stamping the test ingots and pieces, I simply wish to call ention of the Board to the fact that a dishonest firm might make one good heat e this for all future test pieces. The only way I see to prevent this, without the word of the firm, is the system of stamping I propose. This is more im- t than it would seem at first, for, unless the inspector is certain that his test omes from the heat he wishes to test, of course his results are useless. This will require much careful attention and inspection, but if the word of the to be taken, why inspect at all? Why not take their word that the steel is ı required, and save time and labor?

›nclusion, I would respectfully recommend that the following articles be fur- each inspector, or the inspectors at each place, viz: 1 pair of calipers; 1 four- le inted); 1 steel tape for measuring angles, &c. (at least 50 feet); 1 gauge $\frac{1}{1000}$ inch, for measuring test pieces; 1 gauge for measuring final elonga- tch A appended); 6 pocket note-books with soft backs, printed according B appended; 1 4-quire note-book for smooth work, printed according to form ›ded; lead pencils, pens, &c.

If it is required to find elongation under first strain, the inspector should nished with an electric contact machine measuring to not more than $\frac{1}{1000}$ (thousandth) inch, similar to that described in Thurston's "Materials of Engin Part II., p. 369. One thermometer for quenching tests, fitted with case to pocket, should also be furnished each inspector who has quenching tests to n

Very respectfully,

B. C. BRYAN,
Assistant Engineer, U

Rear-Admiral E. SIMPSON, U. S. N.,
President of Naval Advisory Board,
Navy Department, Washington, D. C.

FORM B.

Date ....

Number of—	C	Mn	P	Si	S	Stress per gauge.	Elonga 8 inc
Heat. Piece.							
Original dimensions ...... { —— × —— / —— × —— / —— × —— / —— × —— }							
Mean dimensions							
Area section							
Elastic limit (per gauge)							
Elastic limit (per square inch)							
Ultimate strength (per gauge)							
Ultimate strength (per square inch)							
Fractured Dimensions { Thickness { —— / —— / —— }							
Fractured Dimensions { Mean ...... —— × ——							
Reduced area							
Reduction of area (per cent)							
Total elongation (per cent)							
Time .... { Commence							
Time .... { End							
Time of test							
Appearance of fracture							
Breaking weight per gauge							

REMARKS

FORM C.

Tests of steel for ——, made at ——, by ——.

Date	Per cent of					Heat. Mark	Dimensions of section		Area section		Elastic limit.		Ultimate per cent.		Reduced area.	Elongation.	Time.	Elongation for first strain = —— pounds.	Modulus of elasticity	Elongation at maximum load.	Plastic strength	
	C	Mn	P	Si	S		Original	Fractured.	Original	Fractured	Gauge.	Per square inch.	Gauge.	Per square inch.							Per gauge.	Per square inch

[Naval Advisory Board—Office of Inspector of Material.]

PITTSBURGH, PA., *May* 28, 1884.

SIR: In reply to the Board's circular letter of the 24th April, 1884, I have the honor to present the following:

"The initial stress to be as near the elastic limit as possible, which limit is to be carefully determined by the inspector in a special series of tests."

This article in the present circular is not enforced; the initial strain being used is 25,000 pounds per square inch.

Observations to be made of the elongations on a length of 8 inches corresponding to the initial stress, 40,000 pounds and 50,000 pounds per square inch, and after fracture.

The elongations previous to fracture have not been taken, owing to the difficulty uncertainty without proper instruments. Four elongations would be registered, which would furnish sufficient data, and not be too bulky. These four elongations are about equidistant in regard to stress.

Very respectfully,

L. D. MINER, U. S. N.,
Inspector of Material.

Rear-Admiral E. SIMPSON, U. S. N.,
President of the Naval Advisory Board.

[Office of Inspector of Hulls for U. S. Navy, at the Delaware River Iron Ship Building Works.]

CHESTER, PA., *May* 21, 1884.

SIR: In compliance with your circular order of the 24th ultimo, I have to state duties as inspector of hulls do not warrant any suggestions as to changes in "tests of steel for cruisers," as modified by existing orders from the Board. On the contrary, the results of the work up to the present time go to show that the limitations of the various properties of the material have been wisely determined. Of all plates, beams, angles, and rivets delivered here for the cruisers, the number of failures have been surprisingly few, and these, in my opinion, only when the pieces were subjected to unreasonable stress while cold. Opportunities for the observance of steel rivets which have been cut out, after having been riveted up, have been numerous, and in all cases have shown evidence of their superior strength and toughness. I am, therefore, as far as my duties enable me to judge, of the opinion that no changes in the existing specifications of tests, in so far as they apply to hulls, should be made.

Very respectfully, your obedient servant,

J. F. HANSCOM,
Assistant Naval Constructor, U. S. N., Senior Inspector of Hulls.

Rear-Admiral E. SIMPSON, U. S. N.,
President Naval Advisory Board, Navy Department, Washington, D. C.

[Office of Inspector of Hulls for U. S. Navy at the Delaware River Iron Ship Building Works.]

CHESTER, PA., *May* 23, 1884.

SIR: In compliance with instructions contained in Board's letter of the 24th ultimo, I have to state that my present duties as inspector of hulls suggest no reasons for recommending any changes in the "tests of steel for cruisers," as altered by existing orders, and indeed the success which has attended the working of this material for the hulls of the cruisers—the percentage of failures having been remarkably small—does not warrant me in suggesting the adoption of any additional tests, regulations, or restrictions.

Very respectfully, your obedient servant,

JOHN B. HOOVER,
Assistant Naval Constructor, U. S. N., Inspector of Hulls.

Rear-Admiral EDWARD SIMPSON, U. S. N.,
President Naval Advisory Board, Navy Department, Washington, D. C.

[Delaware River Iron Works.]

CHESTER, PA., *May* 27, 1884.

SIR: I have the honor to acknowledge the receipt of your communication of the 24th ultimo, relating to a new circular for "Tests of Steel for Cruisers," and to report that additional tests or regulations may be considered desirable as suggested by my present duties.

In obedience thereto, I have respectfully to report that, as regards the qualities of, and the manner of making the tests of, materials for the hulls of the cruisers, there are no changes I have to recommend.

In relation to the character of the material employed in their boiler construction, it has been suggested to me that if the limits of tensile strength of the plates were slightly reduced, with an additional increase in the percentage of ductility, a material superior in some particular respects to that now employed would be obtained.

Some of the advantages I claim, and to be greatly desired, are: avoidance of initial stress in the portions of the plates when locally heated, as in flanging; the temper of the material would be less altered round the rivet-holes, as in punching; the process of working more freely and perfectly accomplished; less liability to injury from heavy usage and improper working; can be worked and shaped to form required with greater facility; greater immunity from danger of fracture after boiler is completed.

A number of instances are known where boilers have fractured in testing at a much less pressure than that required to be imposed.

I think it necessary that the manner of making the tests of all boiler-plates be the same as at present prescribed.

I would recommend that the ultimate tensile strength be not less than 56,000 pounds and not more than 60,000 pounds; the ductility in 8 inches to be not less than 28 per cent.

With the increase in the percentage of ductility, the increase of thickness of the plate requisite for strength would be but slight, and necessary only in the cylindrical portion of the shell of the boiler; the strength and rigidity of the flat surfaces being dependent upon the usual methods of bracing. This additional thickness would compensate for corrosion.

All portions of the boilers to be made of the same kind and quality of material.

Very respectfully, your obedient servant,

A. W. MORLEY,
Chief Engineer, U. S. N., Inspector of Machinery.

Rear-Admiral E. SIMPSON, U. S. N.,
President Naval Advisory Board.

[Morgan Iron Works.]

NEW YORK, *May* 29, 1884.

SIR: In answer to the Board's order of April 24, 1884, to present in a concise form any additions I may think desirable to introduce in a new circular for "Tests of Steel for Cruisers," I have to recommend the following tests for *boiler-plates:*

From one plate rolled from each ingot, a test piece 6 inches wide and 19 inches long must be sheared off cold.

This test piece must then be heated at one end to a bright red heat for not less than one-third of its length nor more than one-half its length, and, while hot, the part marked A in the drawing must be bent round a curve of which the diameter is not more than one and one-half times the thickness of the plate under test.

After the plate is cold and unannealed, holes must be punched of one-eighth of an inch greater diameter than the thickness of the plate, and spaced three diameters from center to center on a line one and one-half times their diameter from edge of the plate, the center of first hole to be three diameters from center of inner curve of bend.

Where the edge of the doubled part meets the surface of the plate, a row of intersecting holes (B) must be punched cold, cutting the plate from its edge to the middle, and then the flange (C), unannealed, is to be bent cold, to a right angle with the plate, with the same curve as A. All plates accepted must show neither cracks nor flaws after these tests.

If a piece fails, *all* the plates rolled from the *same* ingot must be tested.

REASONS.

The necessity of an addition to the admirable tests ordered by the Board is proved by the numerous failures of material having the inspector's mark. In my opinion the tests should be as severe as the punishment which the metal receives during the ordinary operations in making a boiler.

The test I propose is practicable and not expensive; it will show in *one* piece the effects of shearing, punching, bending hot and cold, and also local heating. Good mild steel suitable for boilers should stand this test in *addition* to those now in force.

Very respectfully,

ISAAC R. McNARY,
Chief Engineer, U. S. N.

Rear-Admiral E. SIMPSON, U. S. N.,
President Naval Advisory Board.

[Morgan Iron Works.]

NEW YORK, *May* 27, 1884.

R: In reply to your letter of April 24, I would state that I have carefully con- red the matter of "Tests of Steel for Cruisers" more especially with reference to erial used for boilers, and I have little to add to a subject which has been so much ussed of late years.

far as my experience goes with boiler-plates of mild steel, I do not think it has been made with that certainty as to its homogeneity that is desirable for full con- nce in it. I think this is more a question of the thorough mixing of the ingre- its in the furnace previous to the casting of the ingots than their quantity or lity. Of course the better the ingredients the better, as a whole, the resulting erial.

think that greater stress should be laid on the elastic limit when tests are made, ractically that is the measure of strength. Reduction in the tensile strength and igation required by existing specifications should not be thought of, but rather an ease of the former demand, for I can see no advantage to be gained by the use his material over that of wrought iron if the tensile strength of the former re- ins equal to or little superior to that of the latter.

n the working of these plates for boilers, it appears to be a fact that when they have d well the tests, both cold and hot, they fail when worked at a heat not luminous, what is known as a "black heat." This must take place to a greater or less de- e during the process of flanging and local heating in fitting up. A remedy for this, degree at least, would be the flanging of the plates at the time and place of manu- ture, where facilities are better for total and even heating and cooling. This would obviate much of the delay and expense of rejecting the plates at the time and ce of manufacture of boilers, or much of the flanging could be done with the plate l. If a plate is capable of being bent cold to the degree required by the specified s of the Board without injury, why should it require heating for flanging where bend is less? I am of the opinion that all rivet, stay, and brace holes should be led, and where plates are lapped or butt-strapped one plate should be used in place template for drilling the others. I would advocate this apart from any considera- as to the effect upon the plates of punching, and with a view to the accuracy of holes in the plates and straps with regard to each other, and, as a consequence, the ishment of the drift-pin from the boiler-shop. In the case of steel shafts it is a stion whether they should possess great elongation, especially when obtained at expense of hardness and rigidity. I would prefer they should have a high elastic it with a moderate elongation.

Very respectfully,

B. B. H. WHARTON,
Chief Engineer, U. S. N.

PROPOSED NEW CIRCULAR OF TESTS.

'rom the foregoing reports of inspectors, and some of the general re- ts obtained from time to time during this inspection, a new circular been compiled, embodying certain alterations in the system of tests hout any change of requirements. The principal alterations will be nd in the shape and proportions of the test piece, in the method of oving and stamping the test specimens, and in following out the erial of each heat, and in the return to the individual test for boiler- e.

TESTS OF STEEL FOR CRUISERS.

Instructions to Inspectors.

NAVY DEPARTMENT,
Washington, ——— ——— 188-.

he following rules are prescribed in order to insure the fulfillment he clause of the act of Congress of August 5, 1882, "Such vessels * * to be constructed of steel of domestic manufacture, having iear as may be a tensile strength of not less than 60,000 pounds he square inch, and a ductility in 8 inches of not less than 25 per um."

I. All ship plates, beams, angles, rivets, bolts, boiler-plates, and stays to be inspected and tested at the place of manufacture by a naval inspector of material, and to be passed by him, subject to restrictions hereinafter mentioned, before acceptance by the ship-builders, whether Government or private, for incorporation into said vessels.

II. Every plate, beam, and angle supplied for these vessels to be clearly and indelibly stamped in two places and with two separate brands: (1) with that of the maker, which shall distinguish the name of the manufactory or company, (2) with the regulation brand of the naval inspector of material. The latter not to be stamped upon any of the above-mentioned material until it shall have passed an inspection for surface or other defects of manufacture and the physical tests, have been accepted by the inspector, and have been stamped with the maker's brand.

In case of small articles passed in bulk, the above-mentioned brands shall be applied to the boxing or packing material of the objects.

No steel material to be received at the building yards for incorporation into vessels except it bear, either upon its surface or that of its packing, both of these brands, as evidence that it has passed the necessary Government inspection.

III. The weight of all plates, beams, angles, &c., must be obtained by the inspector of material before delivery.

Plates of 12½ pounds per square foot and less, and strips and bars of 6 pounds per lineal foot and less, may be accepted if the weights vary between 3 per cent. above and 5 per cent. below the specified weights.

All other plates and shapes may be accepted if the weights vary between the specified weights and 5 per cent. below them.

All plates and shapes not being within the limits here specified may be rejected.

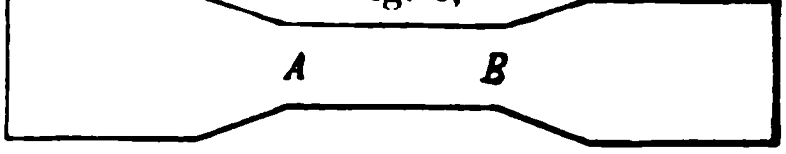
TESTS.

All material except boiler plates should be tested by heats, as follows:

A specimen ingot or bloom shall be selected and rolled into a plate or bar and test pieces cut therefrom, provided always that the test pieces shall have received no more working than that which the finished material from the heat would receive.

Four test pieces of the form shown in Fig. 1 for plates—a square or round, in condition as finished at the rolls, may be used for tests of shapes—shall be made and tested for each heat.

Fig. 1,



The length A B must be at least 8 inches of uniform cross-section of which the area should not be less than $\frac{1}{2}$ or more than $\frac{8}{10}$ of 1 square inch.

The reduction of breadth throughout the length A B should be just sufficient to prevent failure in the grip.

The test pieces must not be annealed unless the finished material is to be annealed.

Each test piece shall be submitted to a direct tensile stress until it breaks, and in a machine of approved character.

The initial stress to be 30,000 pounds per square inch.

The first load to be kept in continuous action for one minute. An ob-
rvation to be made of the corresponding elongation measured upon
e original length of 8 inches.

The stress to be then increased slowly until the principal elastic limit
determined, after which additional loads will be added at intervals
time as nearly as possible equal, and separated by half a minute;
e loads to produce an increase of stress of 5,000 pounds per square
ch of original section of the test piece until the stress is about 50,000
unds per square inch of original section, when the increments of
ress should not exceed 1,000 pounds per square inch. Upon close ap-
oach to the probable ultimate strength, the load to be increased grad-
lly and its maximum value carefully noted.

The final elongation to be that obtained after rupture.

A list of all ingots made from each heat must be supplied to the in-
ector. Each ingot should be stamped in his presence with the num-
r of the heat. He should also see the test plate or billet cut off,
amped, and rolled, and place a private stamp upon it in such a way
at each test piece will have the impression of the stamp near one end.

CONDITIONS OF ACCEPTANCE.

In order to be accepted, the average of the four test pieces must show
n ultimate tensile strength of at least 60,000 pounds per square inch of
iginal section, and a final elongation in 8 inches of not less than 23
r cent.

Material which shows a strength greater than 60,000 pounds per
uare inch will be accepted, provided the ductility remains at least
3 per cent.

CASES OF FAILURE.

If the average of these four test pieces, numbered 1, 2, 3, 4, (called
est I.), fall below either of the required limits, the ingot from which
eces 1, 2, 3, 4 were cut shall be rejected, and Test II. made, consist-
g of pieces 5 and 6, cut from a second ingot. If the mean of the re-
lts of these two fall below either of the above limits, the entire lot
all be rejected. If it be successful, Test III., or the mean of pieces
and 8 cut from a third ingot shall decide.

If in any of the Tests I., II., III., any single piece shows a tensile
ress less than 58,000 pounds or a final elongation less than 21 per cent.,
e ingot from which it was taken shall be rejected and that test consid-
ed to have failed, regardless of its average.

QUENCHING TEST.

IV. A test piece shall be cut from each plate, angle, or beam, and
ter heating to a cherry red, plunged in water at a temperature of 82°

Thus prepared it must be possible to bend the pieces under a press
hammer so that they shall be doubled round a curve of which the
ameter is not more than one and a half times the thickness of the piece
sted without presenting any trace of cracking.

These test pieces must not have their sheared sides rounded off, the
ly treatment permitted being taking off the sharpness of the edges
th a fine file.

Inspectors may require a cold bending test when considered necessary.

ANGLES, BEAMS, BULB BARS, T BARS, &c.

V. Angle bars are to be subjected to the following additional tests: A piece cut from one bar in twenty to be opened out flat while cold under the hammer; a piece cut from another bar in the same lot shall be closed until the two sides touch while cold.

Bulb and T bars are to be submitted to a closing test similar to that prescribed for angle bars.

Bars submitted to these tests must show neither cracks, clifts, nor flaws.

RIVETS.

Each 1,000 pounds of rivets from the same heat of metal shall constitute a lot and be accompanied by two sample bars, each 18 inches long for a tensile test. These samples for tensile test shall be cut from the bars from which the lot of rivets is made and be stamped with a number which shall also be placed on each box or package of that lot.

These samples to be subject to the same tensile test as that required for plates.

The lot of rivets of which this sample bar does not fulfill the requirements of tensile strength and elongation required for plates is to be rejected.

From each lot six rivets are to be taken at random and submitted to the following tests, two rivets to be used for each test:

(1) Two rivets to be flattened out cold under the hammer to a thickness of one-half the diameter without showing cracks or flaws.

(2) Two rivets to be flattened out hot under the hammer to a thickness one-third the diameter without showing cracks or flaws.

(3) Two rivets to be bent cold into the form of a hook with parallel sides without showing cracks or flaws.

BOILER PLATES.

Two tensile test pieces shall be cut from each plate rolled for boilers and one quenching test piece, which shall be tested as before described; except that, in the tensile tests, the initial stress may be 25,000 pounds to the square inch.

The ductility in 8 inches must not be less than 25 per cent., and the ultimate tensile strength must not be less than 57,000 pounds, and not more than 63,000 pounds; and no single piece must show a less tensile strength than 57,000 pounds to the square inch.

No steel for boilers which is to be worked at a heat or to be annealed after working in the boiler shop shall be annealed at the works.

The acceptance of material under these tests will not relieve the contractor from the necessity of making good any material which fails in working or may be rejected by the inspector.

PROPOSED DETAILED INSTRUCTIONS TO INSPECTORS OF MATERIAL.—In accordance with the experience gained, the method of conducting the tests and inspection may with advantage be modified as contained in the following instructions. The principal changes are in the method of conducting the tensile tests, the addition of a cold bending test under certain conditions, and more explicit directions as to the quenching test.

DETAILED INSTRUCTIONS TO INSPECTORS OF MATERIAL.

NAVAL ADVISORY BOARD, NAVY DEPARTMENT,
Washington, ———, ——, 188-.

In addition to the instructions contained in the requirements for "Tests of Steel for Cruisers," inspectors will be guided by the following:

(1) TESTING APPARATUS AND METHODS OF TESTS.

The inspector will, as soon as practicable, after reaching his post, carefully examine all the appliances available for the proper inspection of material, consult with the superintendent as to making the tests, and make a special detailed report to the Advisory Board of the kind and efficiency of the apparatus and the arrangements which have been decided upon for making the different tests. Such report to include a description of the testing machine to be used, accompanied by a cut, or if possible, detailed drawings from the maker; whether the machine is worked by hand or power; if hydraulic, the condition of the pumps, valves, leading pipes, plunger packing, &c.; the method of holding the pieces in straining, a record of any dead weight tests for accuracy which may have been made at the works, and the feasibility of repeating them; the measuring instruments in use or available; the proposed method of heating the pieces for quenching test, and, if in a furnace, a description of it, including whether or not the pieces will be in direct contact with the flame, the kind of fuel used, and the degree of control exercised over the flame; the proposed method of bending such pieces, and, in the case of inspectors of material for shapes or rivets, the methods of making the special tests required for such material; and finally whether or not all such facilities and proposed methods are sufficient for, and in accordance with, the determinations of such quantities and the observance of such precautions as are contained in the requirements of "Tests of Steel for Cruisers" or hereafter in these instructions, together with such other matters as he may consider of importance.

(2) METHODS OF MANUFACTURE.

He will render himself as familiar as possible with the principles and details of manufacture of the material at the works at which he is stationed, paying special attention to the manipulation and heating of the material. But he will take care to conduct his inquiries only so far as he may be willingly accorded facilities by responsible persons. In no case shall he attempt to exercise any control whatever over the manufacture beyond the actual testing, inspection, weighing, and stamping of the material, except as regards annealing of steel intended for certain parts of boilers, as duly specified in the "Tests of Steel for Cruisers," and as hereafter mentioned.

(3) RECORD OF INSPECTION.

He will keep a complete record of every piece of metal tested for the Government, in accordance with the blank forms and note books furnished, with such other items as he may deem necessary, whether such piece fulfills the requirements of a successful test or not.

(4) REPORTS.

At the end of each week he will make a detailed report of tests and inspection to the Advisory Board, together with such information or suggestions as he may deem necessary in carrying out the work.

(5) ALLOTMENT OF MATERIAL—REGISTER MARKS.

For purposes of recognition and record, all plates, beams, and bars are to be divided into lots of twenty pieces as finished by the rolls, and each piece and its corresponding test piece or pieces marked with a distinguishing register mark, consisting of a number and one of the first twenty letters of the alphabet, the number to denote the lot, and the letter the individual piece in the lot. Lots of material shall be numbered consecutively in the order in which they are inspected, ship and boiler material separately; and, as far as possible, all the pieces of a lot shall be from the same cast or heat, the heat number being rigidly followed from the cast to the finished product.

The register mark of rivet bars and rivets will consist of the lot number alone.

The register mark shall be legibly painted on each piece of material, plates near one corner, angles on the inside, beams on the web; the paint to be mixed with

benzine or such other substance as will effectually resist the action of the weather for a long time; the corresponding test pieces to have the register mark stamped cold near one end. In the case of test pieces taken across the direction of rolling, a cross (+) will be affixed to the register mark on the test specimen.

(6) REMOVAL OF TEST PIECES.

While the inspector is to use his judgment as to the part of the material from which the test pieces are taken, he will in no case, except by the request or permission of the superintendent or other responsible officer of the works, intrench upon the finished measurements of the piece in removing them. As far as possible, pieces of the scrap will be taken, and, if they fulfill the requirements, the piece will be passed. Should they fail, however, the piece need not thereby be condemned; but the inspector, if he so desires, or at the request of the superintendent, may make a second test of a piece taken from the body of the material. Test pieces, especially of shapes, may be removed by the hot saw, with due precaution as to the correspondence of the piece and test specimen. Pieces for cold bending, opening, or closing tests are preferably so removed, and, if removed by shearing, no part of the test piece should have been under the shear-knife.

In removing the tensile test pieces from the specimen plate of a heat of material for ship plate, the original top and bottom of the ingot shall be noted and the pieces numbered systematically accordingly. Similarly for boiler plate, the pieces being removed as far as possible from diagonally opposite corners.

(7) CONDEMNATION OF MATERIAL AND CASES OF DISAGREEMENT.

All condemnations of material will be immediately reported to the superintendent of the works, or his authorized representative, who shall have access to the entire record of tests and weights. Test pieces connected with such cases shall be preserved until their removal is authorized by the Board.

In case of any disagreement arising during the inspection, the matter shall be at once referred to the Advisory Board for settlement. It is, of course, preferable that all tests shall be made in the presence of a qualified representative of the management of the works.

(8) THE TENSILE TEST.

(*a*) *Tensile test pieces.*—In removing such pieces from plates, care should be taken that they are curved as little as possible, and in subsequent cold straightening they should not be treated in such a way as to materially hammer-harden them: If removed by punching, a margin of not less than one-eighth of an inch will be left all around the finished dimensions, to be removed by a cutting tool in shaping. All other tensile test pieces requiring to be shaped should be removed by a cutting tool, and should have been perfectly straightened while hot as finished by the rolls. When the modulus of elasticity is to be determined, the degree of straightness of the piece should be carefully noted.

As the original sectional area of the pieces is to lie between certain limits, it is suggested, for convenience in the preparation of the pieces, that a series of wooden templates be prepared of dimensions suitable to graded thicknesses and marked accordingly with distinguishing marks to be placed on the specimens after straightening, for the guidance of the mechanic in roughing them out.

(*b*) *Measuring the piece.*—The original sectional dimensions of the prismatic portion of the piece shall be obtained in at least three places, viz, in the middle and near each witness mark. If the sectional area at the middle be the least of the three, the corresponding dimensions shall be taken for test. If either of the other sections be less than at the middle, a mean shall be taken between the dimensions of the least section and at the middle. In any case should the difference between the sectional areas in any two places be greater than 3 per cent. of the greatest area, the test piece shall be discarded as unfit for test.

(*c*) *Extension under initial stress and modulus of elasticity.*—In placing the piece in the grips, care should be taken that it is perfectly central, and the grips must not be so made, or allowed to get into such a condition, as to hold a flat piece chiefly on one side. When the initial extension is to be measured, a stress of about 10,000 pounds to the square inch shall be put on and removed to tighten the piece in the grips and remove low initial strains.

Suitable and approved apparatus being obtained or provided, the extension in the measured length of 8 inches under the initial stress of 30,000 pounds or 25,000 pounds to the square inch, as prescribed in the "Tests of Steel for Cruisers," shall be measured, if possible, within the one minute allowed for such initial straining. Then the

lus of elasticity will be 240,000 or 200,000 pounds, for ship and boiler materia ;tively, divided by the corresponding observed extension and be recorded to the st 1,000 pounds. Great care should be exercised in making this observation that roper stress is uniformly maintained and the measuring apparatus is in no way ·bed.

Principal elastic limit.—The elastic limit is to be obtained as follows: The load slowly increased above the initial load, the beam closely following the pump ·w so as practically to maintain a balance at all times, there comes a time when ·am momentarily no longer rises to the pump or screw. At the same time, scru- f the surface of the test piece shows that the adhering mill scale is just com- ng to flake off, generally near the fillets. Both indications should be observed practicable. The corresponding stress will be recorded as the elastic limit, hould be obtained to the nearest 10 pounds.

Ultimate tensile strength, or tensile limit, and the corresponding extension.—Further ,se of stress having been applied by such increments and at such intervals of ,s prescribed in the "Tests of Steel for Cruisers," when, in the judgment of the ·tor, further stated increment of stress would pass or closely approach the maxi- resistance of the piece, the increase of stress shall be applied continuously, fol- g the pump or screw, until the maximum indication is obtained and the beam . At the same time, the extension of the piece should be measured as carefully ccurately as possible. The ultimate strength should be recorded to the nearest unds.

Final strength or resistance.—Following tensile limit, the extension of the piece d proceed slowly and uniformly, and a practical balance should be maintained e beam so that at the moment of rupture the corresponding resistance may be ately obtained. This load divided by the fractured area subsequently obtained the actual resistance of the metal to separation, and should be recorded to the st 100 pounds.

Final elongation.—In removing the pieces from the grips, care should be taken the fractured surfaces are not abraded or struck against any hard substance, so he two parts may be neatly fitted together. The fitting is best done in a suita- ame and so that the fractured area can be immediately measured without change sition. When fitted, the parts may be lightly ta ped together. The increase of h may be measured either directly in per cent. by suitable scale with vernier at- ment, reading to the nearest tenth of 1 per cent., or in inches to the nearest andth, with subsequent division by 8 to reduce to per cent. All elongations rupture, or at tensile limit, should be recorded to the nearest tenth of 1 per cent.

Final area in per cent. of original area.—The pieces having been fitted together, as described, the width of the least section will be measured and its thickness at dge and at the middle in the plane of least width. Then the sum of the thick- at the edges, plus 4 times that at the middle, divided by 6 will be the mean ness, to be multiplied by the least width, as measured, to obtain the fractured the fractured area to be divided by the original area, and the quotient, ex- d in per cent. to the nearest tenth, entered in the proper column.

Fracture.—The fractured surfaces will be examined with a pocket lens and any aces of lamination will be recorded. The nature of the fracture also, whether t or silky, dull, fine or coarse crystalline, and the arrangement of the surface of re, whether plane, double plane, cup, or irregular, will also be noted.

(9) THE QUENCHING TEST.

naking this test, it is necessary to observe certain precautions. If the pieces are l in a furnace, the flame should be kept neutral, *i. e.*, neither smoky nor cutting, f possible, they should be heated by radiation only, out of contact with the If heated in a smith's forge, the fire should be covered or built up, and the regulated so that the flame is neither smoky nor cutting. In such a fire only should be used, and a green or fresh fire will not give the best results. Especial hould be taken that the pieces are uniformly heated. A low cherry red is the ble temperature, and the pieces should in no case be allowed to cool down from er temperature before being placed in the water.

piece used for quenching or cold bending test may be less than 10 inches in length inches in width, except in case of angles too small to allow this width, when eatest width possible is to be taken.

ending all pieces, the inspector will not permit any nursing on the one hand or rly violent treatment on the other. If the bending is done under the hammer, ows should be delivered as square to the surface as possible. In all cases uni- ty of treatment should be observed.

(10) COLD BENDING TESTS.

uld any plate, beam, or bar be finished at the rolls at a very dull red or colorless rature—or for other sufficient reason—a piece shall be removed as prescribed

for the quenching test, and must bend cold to the same extent without crack or fracture, except that such pieces may be removed by a cutting-tool, or, if removed by shearing, the sheared edges may be ground off to any desired extent. In case of failure, the piece shall be rejected.

(11) SPECIAL COLD TESTS OF ANGLES, BEAMS, AND TEES.

The length of pieces for these tests may be not less than 8 inches, to be removed and prepared as previously stated. If bent under a hammer, the blows should be delivered square to the surface.

While the apparent severity of these tests is recognized, no material which has successfully passed the other tests will fail under them unless it be badly laminated or threaded with dirt. In case of failure, the piece shall be rejected and another piece of the same lot tested. Should the failures be numerous, the fact will be immediately reported, and the inspector shall call the attention of the manufacturer to it so that steps may be at once taken to obtain sounder ingots or blooms.

(12) TEST PIECES TO BE RETAINED.

All tensile test pieces, and such other test pieces as may have given rise to dispute or disagreement between the inspector and the authorities of the works, shall be retained until such time as the Advisory Board may permit their removal. Other pieces, which may present any features of special interest in the judgment of the inspector, or have been the subject of special mention or report by him, shall likewise be retained.

(13) ANNEALED PLATES.

Ship's plates may be annealed at the discretion of the manufacturer, but the inspector will understand that no boiler material may be annealed unless expressly authorized by the Board or by the inspector of machinery under its instructions.

(14) GENERAL INSPECTION.

The inspector, or his duly qualified assistant, shall see each plate as finished by the rolls, and each bloom or bar on commencing a rolling, or in case of any difficulty in the rolling, and shall exercise a general supervision at all times as to the condition of the piece as finished by the rolls, especially observing any fluting of plates due to irregular wear of the rolls, any evidences of overheating or too cold finishing, any severe mechanical treatment in straightening at a black heat or when cold. Cold plates should be carefully examined on each side for signs of lamination, or fine cracking, sand or scale marks, scabs, and surface defects generally. Plates must not be cut too near any locally defective portion. Shapes will be likewise examined for surface defects, and, in addition, the width of flanges will be measured, with special attention to symmetry of sections for beams and tees; shaded backs of angles and grooved fillets from careless dressing of the rolls are to be avoided. In all such cases, and others which may arise during this inspection, affecting the excellence of the finished material for the purpose intended, the inspector must exercise his judgment as to the magnitude of the defect, and consult with the responsible parties in regard to rectifying the trouble or rejecting the piece, except in such cases as may be provided for by appropriate test.

(15) WEIGHING MATERIAL.

Each plate, or all the parts into which a plate as finished by the rolls may have been cut, will be weighed, and must fall within the specified limits. In weighing shapes, all beams and bars of the same size and weight per foot of the same rolling should be weighed separately, in quantities, as far as possible, of not less than 2,000 pounds net at one time. The limits of weight may not be satisfied by mixed loads of light and heavy bars; and no single bar which there is reason to believe is without the prescribed limits may be shipped without the special permission of the Advisory Board. In commencing a rolling of shapes, or after the setting of the rolls has been interfered with, the inspector shall inform himself of the results of the sample pieces weighed for the guidance of the roller, and such bars as there is reason to believe do not satisfy the requirements in this regard may be rejected for that order. But every piece rolled, unless defective in shape or finish, should be tested for quality. It should be noted, however, that all parts of a beam or bar will not weigh alike, and the front end will generally be the lightest.

(16) STAMPING THE MATERIAL.

The inspector will be provided with two stamps, the Naval Inspection brand and one of his own initials, both of which shall be affixed to each piece of material when ready for shipment, but only after having passed satisfactory tests and inspection and being within the prescribed limits of weight. Such stamps shall be affixed as near as possible to the register mark for the better identification of the piece.

NOTE.—As soon as possible after reaching the works, the inspector shall request the Superintendent to have made, or otherwise obtain, a special sledge of about the ordinary size and weight, of soft iron or very soft steel, as the stamps are expensive and necessarily of too high temper to absorb the work of many blows from a hard-faced sledge without breaking up.

(17) INCIDENTAL EXPENSES, INSTRUMENTS, STATIONERY, &C.

All instrumen s, books, and stationery required for use in the inspection will be procured by requisition on the Advisory Board, and receipts will be rendered to the Board for all material rece ved.

Incidental postage and telegraph expenses will only be reimbursed through bills made to, and approved by, the Advisory Board.

Expenses for travel will only be reimbursed by the ordinary naval rule of mileage on orders from the Department.

Unless absolutely impracticable, no official expense will be incurred by the inspector without a preliminary authorization from the Advisory Board.

——— ———,
———, *U. S. N., President of the Naval Advisory Board.*

Approved:

——— ———,
Secretary of the Navy.

RECORD OF TESTS.

For the better record of tensile tests, inspectors should be supplied with note-books ruled in accordance with the sample page (Plate V.)— in for better illustration—which shall form part of the inspector's ls and be signed by him at the end of each series of tests reported abular form to be described. The items in the note-book are be- ed to contain all necessary information of the circumstances and de- of tests d can be at any time referred to in the event of any dis- y sing, or for more particular information on any point not n the tabular form. The page should be printed on one side , the other being used for remarks and the details of calculation. hin paper of good quality should be used, so that many tests may be recorded in a single book, which may yet be conveniently carried on the person. Printed copies of the requirements of "Tests of Steel for Cruisers" and of the "Detailed Instructions to Inspectors of Material" should be bound in the note-book, together with several blank pages for the entry of any subsequent instructions.

The condensed tabular form for report and record (Plate VI.) contains the chief features and results of tests, and is believed to embody much information as can be obtained under the circumstances of ordinary test. The results so recorded are in a form suitable for ysis.

PLATE V.

Date, 9 | 19 | 84.

Heat.—5565 Piece.—4 Condition.—Straight.

Carbon .22% Manganese .54% Phosphorus %		Stress per sq. in.	Gauge load.
Initial extension .00805 E = 29,815,000		30,000	16,044
	Original width. Original thickness	35,000	18,710
Marked end	1.244 × .433	45,000	24,070
Middle	1.240 × .432	50,000	26,740
Unmarked end	1.234 × .432	51,	27,270
Taken as	1.238 × .432	52,	27,800
Sectional area	.5348	53,	28,330
Elastic limit (gauge)	22,800	54,	28,860
" " (per sq. in.)	42,635	55,	29,390
Ult. ten. str. (gauge)	35,860	56,	29,920
" " " (per sq. in.)	67,050	57,	30,450
Ext. at tensile limit	1.54 ins. 19.25%	58,	30,980
Final elongation	— ins., 23.3 %	59,	31,510
Time — Commence	2 hrs. $8\frac{1}{2}$ mins	60,	32,040
Time — End	2 hrs. 21 mins	61,	32,570
Time — Of test	$12\frac{1}{2}$ mins	62,	32,100
Final gauge load	31,000	63,	32,630
" stress per sq. in.	104,870	64,	33,100
Fractured area.—		65,	33,690
t_1 =	.319	66,	34,220
t_2 .303 4 t_2 =	1.212		
t_3 =	.311		
	6) 1.842		
Mean thickness	.307		
Fract. width	.963		
" area	.2956 Ditto % 55.28		
Fracture.—Silky, irregular cup.			

PLATE VI.

Tensile tests.

Heat	Marks	Carbon	Manganese	Phosphorus	Original section: Width	Original section: Thickness	Original section: Area	Fractured section: Width	Fractured section: Thickness at edges and center	Fractured section: Area	Elastic limit	Ultimate tensile strength	Elastic ratio	Final elongation	Final area in per cent of original area	Modulus of elasticity	Elongation at tensile limit	Stress at rupture: Lbs. per sq. in. of original area	Stress at rupture: Lbs. per sq. in. of fractured area	Time of test	Appearance and nature of fracture	Remarks
					Ins.	*Ins.*	*Sq. ins.*	*Ins.*	*Ins.*	*Sq. ins.*	*Lbs. per sq. in.*	*Lbs. per sq. in.*	*Perct.*	*Perct.*			*Perct.*			*Mins.*		
400[illegible]	2 14				1 [illegible]54	417	5229	936	300 .272 308	2646	40,160	62,700	64.06	25.5	50.60	30,200,000	19.0	54,120	106,950	17	Silky-plane	

PART III.

COMMERCIAL TESTING.

The primary object of all commercial testing is to insure sufficiency of strength in the finished structure, and, in general, also, the manufacturer desires to protect himself from the delays and additional expense due to failures of material in working. The nature of these tests, therefore, is always such as to subject the material to extreme cases of the stresses developed in the structure and during construction. The application of mathematical theories and special systems of scientifically-conducted tests allow the structural stresses to be resolved into the three principal stresses of tension, compression, and shearing, and certain permissible limits of corresponding resistance to be applied in each case. Whenever possible, loads producing sufficiently extreme stresses are applied to the finished structure, notably in the case of boilers and bridges, when the manufacturer becomes specially interested in the qualities of resistance of the materials employed, and, if responsible, resorts to preliminary testing in order to insure them. When the structure cannot conveniently or at small expense be subjected to sufficiently extreme stress to insure at once the excellence of material and workmanship, it becomes necessary for the manufacturer to work to specifications supplied by the consumer, who must then ascertain that the material possesses the requisite qualities by such tests as he may deem necessary. Even when the structure can be subjected to proof, the large direct and incidental cost of failure under proof, or subsequently, very generally makes it desirable for the consumer to supply specifications, by which course, also, he largely controls the cost of production.

Accordingly many systems of small testing have been used, in which, by tests carried out on representative small pieces, it is sought to insure efficiency of strength and other qualities in the structure. A to just how far the results of these tests are representative of the m terial in the structure and should form the basis of designs, enginee differ, and special tests on a large scale are required to give thei definiteness. The differences thus developed are due to three mai causes—(1) lack of knowledge of the laws governing stress and strain pieces of different sizes and proportions, (2) want of uniformity in th quality of the material, and (3) initial stresses set up in manufacture. O these the first presents a large field for special inquiry by no means ex hausted; the second may be covered, to a certain extent, by properly-devised tests on a commercial basis, but is well supplemented by special research as to the main causes; to avoid the third constitut good workmanship, the chief source of reputation to the manufacturer. The last cause of difference is evidently widely variable, though mechanical appliances are narrowing its limits. It constitutes one of the chief necessities for the requirement of high ductility so common in connection with the material for built-up structures. Could these initial stresses be avoided, a much harder and stronger material could be used in the large majority of structures, with a diminished factor of safety and great consequent lightness. But the average conditions of working often necessitate a quality of material such that it may undergo

considerable strain or distortion without approaching dangerously near its ultimate strength. In some cases, also, as in the bottom plating of vessels subject to grounding, in those portions of a boiler in contact with the fire, or in the plating and framing behind armor in armor-clad vessels, the quality of high ductility in the material is especially necessary for the purpose served.

Accordingly, requirements for tensile strength and ductility, varying with the nature of the work and its intended cost, have for some time been demanded, the pieces for test being generally small and of conventional, but by no means uniform, pattern. In a sense, the results so obtained may be considered as gauging the intrinsic quality of the material, so that they are frequently deemed as affording a measure of its fitness for the other principal stresses of compression and shearing, especially as direct tests of the corresponding resistances are more elaborate and costly. The tensile test has thus become the chief, and in some cases the only, measure of quality, and many machines designed to subject pieces of various sizes and proportions to more or less accurately gauged tensile stress have been constructed and are in use.

In compression, the results obtained from small pieces bear such an uncertain relation to the resistance of large pieces, and the tests require such care and accuracy, that such tests are not in general use, except perhaps for the materials of masonry.

In shearing or torsion the relation of resistance to that under tension is better known and more definite, so that the sufficiency of the latter test is more apparent. In the case of rivets, however, especially of steel, subjected to combined and frequently high initial stresses, it often becomes necessary to test them under, as near as may be, the conditions of practice.

When metal is to be flanged or bent cold or hot, or suddenly cooled from a heated state, corresponding tests, developing extreme stress, are frequently made, both in order to insure freedom from failure under treatment, and sufficiency of strength in the final condition.

A complete system of commercial small tests for metal structures consists therefore of—

(1) The tensile test, with requirements for ultimate tensile strength and final elongation or ductility—sometimes also conceived to be measured by the reduction of area—and in some cases, for the refined qualities of elastic limit and modulus of elasticity, the latter the measure of stiffness.

(2) For rivets, shearing tests approximating to the conditions of practice; and, incidentally, tensile tests as a general measure of quality.

(3) Hot or cold bending tests, or both.

(4) Tests for hardening quality on rapid cooling, sometimes, though erroneously, called "temper tests," but better known as "quenching tests."

Any or all of these tests may be carried out on a greater or less number of specimens, with corresponding representative value.

A variety of other tests has been proposed, and some are in more or less extended use. Such are tests of the change of condition due to punching and shearing, transverse tests for rolled beams, direct torsional tests, tests for wearing quality, and the well known impact or "drop" test for rails.

The above system of tests has never, we believe, been applied to other material than mild steel, though the tests under each heading have been separately used for a variety of materials. Owing to the irregularity of this metal, as produced by the best makers, but also largely to in-

experience in its treatment, in the early stages of its manufacture and use, mild steel was much more elaborately tested than the iron which it replaced, and especially so for ships and marine boilers. When adopted for these constructions, the various governments and marine insurance societies using it or sanctioning its use, after elaborate preliminary tests, exacted more or less rigid requirements of the nature above described; and, while in some cases they have been somewha relaxed, they are still very generally demanded and are frequently ex tended. The requirements of the French navy, the first to use mild steel extensively for ship construction, are given in the Appendix, together with those of the British admiralty and the various insurance registries, and have been already discussed. The experience with the material in this country in boiler, bridge, and ship construction, prior to the adoption of mild steel for the hulls of ships for the United State Navy, has been considered in the Introduction, while the consideration governing the requirements adopted by the Department, with their subsequent modifications, the chief features in the production of steel mad under the Board's supervision, with the results in detail and summary have been given at length.

Much of the success of testing as a guide to construction depend upon the details of the work. Different men with different method will show very different results from the same material. In order to make the results obtained at different works directly comparable and of standard value, it was therefore necessary to specify the exact method of testing, and leave as little as possible to accident or the individua judgment of the inspector, the disagreeable necessity for which so ofte arises in most inspection. The system of tests, besides insuring the desired quality of material, has also produced information of theoretical value. We have spoken of commercial tests, or tests on a commercia and comparatively inexpensive basis, as distinguished from scientific tests made purely for purposes of investigation. The possible usefu application of the results of commercial testing to the solution of cer tain problems of great theoretical importance, always within the limit of the essential nature of each test, is advanced in this report from ce tain results of great theoretical interest to be hereafter considere The very large amount of commercial testing done as compared wi the relatively limited extent of testing for scientific inquiry constitut in itself a great advantage and emphasizes the desirability of obtaini the maximum of information from the tests commonly made. Besid which, there are so many conflicting causes governing the behavior metals, that numbers of tests are always necessary for a fair idea average or extremes of any one quality.

THE TENSILE TEST.

Presupposing the general use of machines accurately gauging t load and under reasonable control, the various forms of specimen a methods of testing in use, with their consequent effect on both tens strength and ductility, render it necessary in each case to specify acc rately the conditions of test. As yet the results of any one system a not directly comparable with those of any other. The necessity, fr an engineering point of view, of standardizing the test piece and t method of test is very generally recognized, but the loss of value the tests already made on any system to be discarded, and the lack facilities in many places for carrying out tests on any of the syste most generally favored by those who have studied the subject, have far prevented it.

pieces.—The principal forms of test piece which are or have been
ı this country are—
'he groove form (Figs. 10 and 11), both flat and round, drilled or
ɔut for the former and turned out for the latter. The only re-
·nerally desired from this test is the tensile strength, though the
ed area is sometimes obtained, and the ductility arbitrarily meas-
n an original length of one inch laid off equally on each side of
ıst width. This form of specimen has the advantage of being
taken from small pieces, and, for materials of small ductility, the
of the tensile strength so obtained is practically correct. For
materials it gives much higher tensile strength and area of frac-
ection than long parallel-sided pieces, though the amount of the
ıce does not seem to lie altogether in the ductility. As so used
tes of wrought iron and the mild steels it is sometimes called the
ıe test," presumably from its use in testing ship and boiler plate.
otless owes its very general use to the ease and cheapness of pre-
specimens for test.
[he short filleted form (Figs. 12 and 13), both flat and round, as
or the Pennsylvania and other railroads, and very generally used
lnance purposes.* Like the preceding, it has the advantage of
easily taken from comparatively small pieces. Both tensile
th and fractured area for ductile material are much nearer the
from long pieces than in the groove form and more uniform, but
ll too high. The ductility is somewhat arbitrary, in that the
red length includes the short end fillets, which are in a different
ion of stress from the straight portion. Being very largely de-
ıt on the proportions of the test piece, the ductility results from
specimens always read very high, especially for the softer mate-
This form is cheaper to fashion than the long filleted form, which
aps the only excuse for its use in testing boiler material.
[he straight-sided form, of any length and any cross-section, pro-
t be uniform along the length, and either planed out or in condi-
finished at the rolls or under the hammer. As planed out on
ges, it is in very general use among bridge engineers for plates
apes of soft metal, and in the rough-finished state is much used
l works for grading the metal.
ıany respects this is the very best form of test piece, involving
ost to fashion, and allowing each portion of the measured length
ubjected to the same stress and equally free to strain or change
n. About its only disadvantage is the danger of breaking in the
a real source of trouble with hard steels, but which can only oc-
h soft steels in case of malformation of test piece or lack of homo-
in the material; and if the first be true to any extent, the speci-
not suitable for test. It is worthy of remark that unless the test
ted by one or other of these causes, soft material shows a very
tendency to break in the middle of the length, and will never
in the grips.
'he long filleted form (Figs. 14 and 15), generally adopted, in a
of 8 inches between fillets, for ship purposes. The history of this
about as follows:
ıe first lever machines, before the use of wedge or friction grips,
st convenient way of applying stress was by a pin and hole con-
ı (Fig. 14), which plainly necessitated a spreading of the ends.

ay be remarked that the results of Sir J. Whitworth's famous fluid-compressed
always from a test piece of this kind.

Table XV.* gives the dimensions of the various flat test pi
eral use.

*Much of the information in both tables is taken from a recent pap
British Institution of Civil Engineers on "The Adoption of Standard F
Pieces for Bars and Plates," by William Hackney, B. Sc., Assoc. M. Inst

Engineer or administration using test piece.	Authority.	Length.	Diameter.	Ratio of diameter to length.	Estimated ultimate stretching of same sample of mild steel if cut into a test piece of each proportion.
		Inches.	*Inch.*		*Per cent.*
Sir Joseph Whitworth, Bart., M. Inst. C. E.*	Minutes of Proceedings Inst. C. E., vol. xlii, p. 107	2	0.798	1 to 2.506	44.5
Woolwich Arsenal, test pieces used for—					
Steel	Colonel Maitland, Superintendent of the Royal Gun Factories (private letter, August 26, 1881).	2	0.533	1 to 3.75	37.5
Wrought iron		2	0.754	1 to 2.65	43.5
Cast iron		2	1.066	1 to 1.88	52.0†
		mm.	*mm.*		
Austro-Hungarian State Railway	Tests of Reschitza iron, published at the Paris Exhibition, 1878. (Les Métaux, par H. Lebasteur, Paris, 1878, p. 113.)	150	25	1 to 6.00	32.0
Usine du Creusot	Tests published at the Vienna Exhibition, 1873. (On certain matters affecting the use of steel. By E. Marché, Paris. Journal of the Iron and Steel Institute, 1878, p. 417.)	100	16	1 to 6.25	31.5
Compagnie de Terre-Noire	P. Euverte, Mémoires de la Société des Ingenieurs civils, 1877, p. 329. (Minutes of Proceedings Inst. C. E., vol. xlix, p. 360.)	100	15	1 to 6.6	31.0
Société John Cockerill, Seraing, Belgium	E. Marché, *loc. cit*	100	15	1 to 6.6	31.0
Professor R. H. Thurston	Les Métaux, par H. Lebasteur, p. 286	150	22 to 20	1 to 6.8 to 1 to 7.5	30.9 to 30.2
		Inches.	*Inch.*		
United States Board on Testing Iron, Steel, and other Metals. Test pieces used for steel.	Report of Board on Testing, &c., 1881, vol. ii, pp. 203–396	6	0.625 and 0.798	1 to 9.6 / 1 to 7.52	28.5 to 30.2
		mm.	*mm.*		
Colonel Rosset	Révue d'Artillerie, May, 1875, p. 134. (Minutes of Proceedings Inst. C. E., vol. xliii, p. 417.)	200	25	1 to 8.0	29.8
Compagnie de Terre-Noire	Les Métaux, par H. Lebasteur, p. 72	200	20	1 to 10.0	28.2
R. Pink Hörde, Westphalia	The dephosphorization of iron in the Bessemer Converter. (Journal of the Iron and Steel Institute, vol. i, 1880, p. 57.).	150	15	1 to 10.0	28.2
		Inches.	*Inch.*		
Sir W. Fairbairn	British Association Report, 1869	8	0.772 to 0.69	1 to 10.36 to 1 to 11.59	27.9 to 27.2
		Sw. feet.			
K. Styffe	Iron and Steel, by K. Styffe. Translated by C. P. Sandberg, p. 16	5			
		Inches.			
Cambria Iron Works. Test pieces for steel	United States Naval Inspector of Material	8	0.750	1 to 10.67	27.7
United States Navy Department. Test pieces for steel rivet bar.	Present report	8	0.500 to 0.875	1 to 9.14 to 1 to 16	29.0 to 26.3

TABLE XIV—Continued.

Engineer or administration using test piece.	Authority.	Length.	Diameter.	Ratio of diameter to length.	Estimated ultimate stretching of same sample of mild steel if cut into a test piece of each proportion.
		Inches.	*Inch.*		*Per cent.*
Pennsylvania Railroad *	Various specifications	2	0.625 to 0.750	1 to 2.66 to 1 to 3.2	43.5 to 40.5

* In the test pieces used by Sir J. Whitworth and the Pennsylvania Railroad, the measured length of 2 inches includes sharp fillets at the ends (in the Pennsylvania Railroad to ⅛-inch radius), so that their comparative extensions are somewhat less than as given in the table. Thus Sir J. Whitworth's should probably read 40.5, and the Pennsylvania Railroad's 39.0 to 36.0 per cent.

				length
London and Northwestern Railway Company Crewe Works	Extended report on steel for ship building (Lloyd's Register of British and Foreign Shipping, No 391, 6th December, 1877 p 7.)	2′	(†)	
Sheerness and Chatham Dockyards. Tests of steel and iron boiler plates made at Sheerness in 187[illegible] and at Chatham in 1879	On the comparative endurance of iron and mild steel when exposed to corrosive influences by D Phillips (Minutes of Proceedings Inst C E, vol lix, p 90)	4″	1.51″ to 1.5″	1 to 2.6 to 1 to 2.65
Mr W Parker	On the use of steel for marine boilers (Transactions of the Institution of Naval Architects vol xix 1878, p 175)	4″	4″ to 2.7″	1 to 1 0 to 1 to 1.5
Usine at Creusot	Prof L Gruner Private Letter December 17, 1882)	100mm	20mm	1 to 5
The majority of French railway companies. Test strips for boiler plates	do	200mm	20mm	1 to 10
Ministère de la Marine Française. Circular dated May 11 1876.	Sur les Expériences de Résistance des Matériaux en France et aux États Unis par H Tresca (Annales du Conservatoire des Arts et Métiers 1877)	200mm	Thickness. / Width of strip. Under 5mm / 20mm 5 to 18mm / 30mm 18mm and above. / Thickness of the plate.	1 to 6.6 to 1 to 10
Jern Kontoret, Stockholm	Expériences de force et de traction sur des tôles Suédoises produites par des procédés divers faites aux frais du Comptoir des Forges (Jern Kontoret) Stockholm, 1878	200mm	70 2mm	1 to 2.85
British Admiralty	Steel for ship building. By Henry H West. (Transactions of the Institution of Naval Architects 1880.)	8″	(†)	
Lloyd's Register of British and Foreign Shipping	Extended report &c	8″	(†)	
Mr D Adamson.	On the mechanical and other properties of iron and mild steel. (Journal of the Iron and Steel Institute, vol ii, 1878, p 394)	10″	(†)	
German Railway Union. Tests made between 1876 and 1878.	Organ für die Fortschritte des Eisenbahnwesens Supplement, 1880 (Minutes of Proceedings, Inst C E, vol lxv, p 439.)	400mm	25mm	1 to 16
Albert F Hill	Steel in construction By Albert F Hill (Engineers Society of Western Pennsylvania Engineering News (New York) May 15, 1880 p 170)	For ½″ plate, 18 For ¾″ plate, 15″ For [illegible]″ plate, 12″	1½″ 1¼″ 1″	1 to 12 1 to 12 1 to 12
Mr D Kirkaldy. Usual standard form for plate specimens.	Experimental inquiry into the mechanical properties of Fagersta steel. London, 1873, p 25			1 to 6
Cambria Iron Works. Test pieces for steel	United States naval inspector of material	8″	¾″ and 1″ □	1 to 8 to 1 to 10 67
United States Navy Department. Test strips for steel plates and shapes	Present report	8″	1″ to 1.25″	1 to 6.4 1 to 8
Pennsylvania Railroad	Various specifications	2″ (incl ½″ fillet).	Thickness. / Width ½ or less. / 1½″ ½″ to 1″ / ¾″	1 to 1.33 1 to 2.66

THE LAW OF PROPORTION.

The most remarkable set of experiments as to the influence of f are those made by M. J. Barba, chief engineer of the great French s works of MM. Schneider, at Creusot, from which he deduces a la symmetry, expressing the identity of the percentages of ultimate stre ing in test pieces of the same metal and similar in form.*

We reproduce the following tabular information taken from the pa on "The Adoption of Standard Forms of Test Pieces for Bars Plates," before referred to, as giving the chief results of his experime

The test pieces used were of the pattern shown in Fig. 16.

Fig. 16.

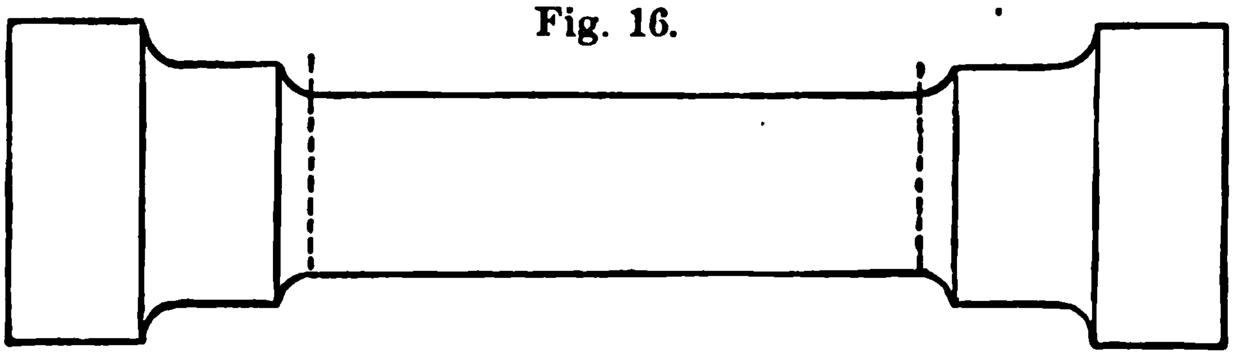


Table XVI.

A billet of extra soft steel was hammered to an octagon of 80 by 80 millime rolled to a bar 30 millimeters in diameter, and very carefully annealed. Three pieces were then cut from it in the lathe and broken, with the following results:

Numbers of test bars.	Diameters.	Lengths between datum points.	Limit of elasticity.	Breaking load.	Total stretch.	Stre
	Millimeters.	*Millimeters.*	*Kil. per sq. millimeter.*	*Kil. per sq. millimeter.*	*Millimeters.*	*Pe*
1	20	200	24.8	37.6	62.0	
2	10	100	24.7	36.8	30.5	
3	5	50	24.8	37.7	15.7	

Table XVII.

Experiments repeated on test pieces of two harder grades of steel, cut from rolled to 40 millimeters in diameter, annealed, and turned down to same propo of diameter to length.

(*a*) MILD STEEL.

Numbers of test bars.	Diameters.	Lengths between datum points.	Ratio of diameter to length.	Limit of elasticity.	Breaking load.	Final area of original area.	Total stretch between datum points.	Str
	Millimeters.	*Millimeters.*		*Kil. per sq. millimeter.*	*Kil. per sq. millimeter.*	*Per cent.*	*Millimeters.*	*Per*
1	6.90	50	1 to 7.24	24.0	42.2	30.7	16.4	
2	10.35	75		24.0	42.0	31.0	24.9	
3	13 80	100		24.2	42.1	30.8	33.0	
4	17.25	125		23.9	41.7	31.4	41.8	
5	20.70	150		23.8	41.6	30.8	50.4	
6	24.15	175		24.0	40.9	30.3	58.0	
7	27.60	200		24.1	40.0	31.2	66.0	
8	31.05	225		24.0	39.6	30.5	76.5	
Means	....	....	....	24.0	41.3	30.8	....	

* "Résistance des Matériaux. Épreuves de résistance à la traction. Étude su allongements des métaux après rupture." Par J. Barba. Mémoires de la Sociét Ingénieurs Civils, 1880, Part I, p. 682.

TABLE XVII.—Continued.

(b) HARD STEEL.

of ...	Diameters.	Lengths between datum points.	Ratio of diameter to length.	Limit of elasticity.	Breaking load.	Final area of original area.	Total stretch between datum points.	Stretch.
	Millimeters.	*Millimeters.*		*Kil. per sq millimeters.*	*Kil. per sq. millimeters.*	*Per cent.*	*Millimeters.*	*Per cent.*
.	6.90	50	1 to 7.24	32.7	64.8	69.5	10.0	20.0
...	10.35	75		36.6	64.9	62.0	14.1	18.8
...	13.80	100		35.7	63.8	62.6	18.2	18.2
...	17.25	125		38.0	63.3	61.6	22.7	18.1
...	20.70	150		40.6	63.5	68.2	27.0	18.0
...	24.15	175		38.1	62.0	64.2	31.7	18.1
..	27.60	200		38.1	63.2	65.6	39.0	19.5
...	31.05	225		....	Not tested.		....	....
....		....	....	37.1	63.6	63.9	....	18.6

on the other hand, the test pieces used are either of different diameters and gths, or of different lengths and equal diameters, the percentages of ultimate g, when portions of the same bar are tested, are very different.
ba gives the following results (Tables XVIII. and XIX.):

VIII.—*Test pieces of equal length between the datum points, but varying from 5 to 20 millimeters in diameter.*

(a) SOFT STEEL.

from the same bar of extra soft steel as that used in the experiments of which the results are given in Table XVI.)

of test ...	Diameters	Length between datum points.	Limit of elasticity.	Breaking load.	Total stretch between datum points.	Stretch.
	Millimeters	*Millimeters*	*Kil per sq millimeter*	*Kil. per sq millimeter.*	*Millimeters.*	*Per cent.*
...	20	100	25.0	37.0	37.5	37.5
	10	100	24.8	36.9	30.2	30.2
	5	100	25.2	37.6	25.0	25.0

(b) HALF HARD STEEL.

...	20	100	34.6	59.3	25.9	25.9
.	10	100	33.5	59.4	21.0	21.0
....	5	100	33.0	60.0	17.0	17.0

IX.—*Ten test pieces of equal diameter and similar in form at the ends, but varying from 50 to 500 millimeters in length between the datum points.*

...rs of test pieces	Dimensions.		Resistance.		
	Diameter	Lengths	Limit of elasticity.	Breaking-load.	Contraction of area.
	Millimeters	*Millimeters*	*Kil. per sq millimeter*	*Kil. per sq millimeter.*	*Per cent.*
.	7.[illegible]	50 to 500	23.7	37.0	68.3

ULTIMATE STRETCHING OF EACH TEST PIECE.

[The lengths of the test pieces between the datum points are given in millimeters.]

	Total millimeters.	Per cent.
50 (=2.91 diameters)	21.0	42.0
100 (=5.81 diameters)	32.0	32.0
150 (=8.72 diameters)	44.0	29.3
200 (=11.6 diameters)	54.5	27.2
250 (=14.5 diameters)	66.5	26.6
300 (=17.4 diameters)	78.0	26.0
350 (=20.3 diameters)	88.0	25.1
400 (=23.3 diameters)	100.0	25.0
450 (=26.2 diameters)	112.0	24.9
500 (=29.1 diameters)	124.1	24.8

M. Barba quotes the experiments, Table XX., to show that the law of similarity, as he calls it—that is, the law that test pieces similar in form give the same percentage of ultimate stretching, whatever their size may be—prevails equally in flat and in cylindrical test pieces, if cut from the same bar and not reduced to the different sizes by hammering or rolling.

TABLE XX.

Numbers of test pieces.	Dimensions of test pieces. Widths.	Thicknesses.	Ratio of width to thickness.	Length between datum points.	Resistance. Limit of elasticity.	Breaking load.	Ultimate stretching. Total stretch between datum points.	Stretch.
	Millimeters.	*Millimeters.*		*Millimeters.*	*Kil. per sq. millimeter.*	*Kil. per sq. millimeter.*	*Millimeters.*	*Per cent.*
1	20	5	4 to 1	50	16.8	37.2	19.5	[illegible]
2	40	10	4 to 1	100	17.1	38.2	39.0	[illegible]
3	60	15	4 to 1	150	20.7	38.9	58.5	[illegible]
Means					18.2	37.4		

Table XXI., also from M. Barba's paper, gives the percentages of ultimate stretching of test strips of steel plate of equal length and thickness but differing in width.

TABLE XXI.

Numbers of test strips.	Dimensions of test strips. Widths.	Thicknesses.	Ratio between width and thickness.	Length between datum points.	Resistance. Limit of elasticity.	Breaking load.	Total stretching. Measured on a length of— 50 millimeters.	100 millimeters.
	Millimeters.	*Millimeters.*		*Millimeters.*	*Kil. per sq. millimeter.*	*Kil. per sq. millimeter.*	*Millimeters.*	*Millimeters.*
1	10	10	1	100	24.8	38.4	18.8	31.[illegible]
2	20	10	2	100	24.6	40.1	22.5	34.[illegible]
3	30	10	3	100	25.4	39.4	24.0	35.[illegible]
4	40	10	4	100	25.0	39.8	26.0	37.[illegible]
5	50	10	5	100	24.6	38.1	28.0	39.[illegible]
6	60	10	6	100	24.9	37.7	30.5	40[illegible]
7	70	10	7	100	24.8	37.8	28.5	38[illegible]
8	80	10	8	100	23.5	38.4	26.0	34[illegible]
Means					24.7	38.7	25.5	[illegible]

This seems to show that, for this hardness of steel and for plates 10 millimeters thi[illegible] when the ratio of width to thickness is as 6 to 1 the maximum elongation takes pla[illegible]

ımination of this table, however, shows that the increase of duc- follows very nearly the law for rounds, if the effective diameter of at be taken as the mean of its width and thickness, until a width millimeters is reached; it is very probable that the ductility of the · pieces was influenced by the method of holding the ends. Indeed 'ery difficult to devise a grip for short wide pieces of plate which at the same time equally distribute the stress and not constrain ›duction and consequently the stretch.

further bearing upon the accuracy of the comparison of results flats and rounds by taking the mean of the two sectional dimen- of the flat for its effective diameter, and affording direct informa- ıs to the sufficiency of a standard test piece, say a $\frac{3}{4}$-inch round, which the results in other forms can be, at least approximately, ·ed, the following Table XXII. is given, being a comparison of the s of a number of heats of Cambria steel as flats and as rounds l on the same machine. The column of elastic ratios is given as ituting a measure of physical condition, which, upon the average, n to be identical for the material in the two forms. Heat 5585 is ed from the average, the differences being beyond the limit of error; at pieces showed evidence of fine lamination and were probably from too near the top ot the ingot. The result is seen to be ly higher elastic limit, ultimate tensile strength, final elongation, eduction of area from the flats. With the exception of the reduc- ıf area, the method of measuring which was somewhat uncertain naccurate, the results are very much as would be expected from xperiments on the effect of length of test piece to be later de- ›d. The higher tensile strength of the flats is also notable as cor- ating the results of these experiments. As a conclusion from this ison, it may be stated that the results of this material as $\frac{7}{8}$-inch ıs would probably be practically identical with those of the $\frac{7}{16}$-inch and it appears probable that the effective diameters as described ı sufficiently accurate basis of comparison in all ordinary cases.

XXII.—*Comparison of results of tensile tests of the same material as flats and as rounds.*

Shape.	Size of piece from which test piece was taken.	Effective diameter.	Ratio of measured length to effective diameter.	Elastic limit per square inch.	Ultimate tensile strength per square inch.	Elastic ratio.	Final elongation.	Final area.	Appearance of fracture.
	Inches.	*Ins.*		*Pounds.*	*Pounds*	*P. ct.*	*P. ct.*	*P. ct.*	
Flat	6 by $\frac{7}{16}$	.8365	9.563	44,030	66,469	66.24	24.43	54.68	Silky.
Round	$\frac{3}{4}$	.7435	10.760	43,135	64,555	66.84	26.05	50.70	Silky; piece somewhat pitted.
Difference ..	....	.....	......	895	1,914	.60	1.62	3.98	
Flat	6 by $\frac{7}{16}$	.8459	9.459	41,576	65,475	63.50	25.25	50.44	Silky.
Round	$\frac{3}{4}$	.7475	10.700	42,630	65,205	65.38	25.20	52.25	Do.
Difference ..	....	.....	......	1,054	270	1.88	.05	1.81	
Flat	6 by $\frac{7}{16}$	.8440	9.479	37,850	60,839	62.22	28.13	51.01	Silky.
Round	$\frac{3}{4}$	.7420	10.780	38,390	59,550	64.47	27.90	47.10	Do.
Difference ..	....	.....	......	540	1,289	2.25	.23	3.91	
Flat	6 by $\frac{7}{16}$	.8345	95.86	46,515	67,100	69.32	24.18	55.09	Silky.
Round	$\frac{3}{4}$	.7410	108.00	42,090	65,620	64.15	23.80	60.20	Silky and crystalline.
Difference ..	....	.....	......	4,425	1,480	5.17	.38	5.11	

TABLE XXII.—*Comparison of results of tensile tests of the same materials as flats a rounds*—Continued.

Heat.	Shape.	Size of piece from which test piece was taken.	Effective diameter.	Ratio of measured length to effective diameter.	Elastic limit per square inch.	Ultimate tensile strength per square inch.	Elastic ratio.	Final elongation.	Final area.	Appearance of ture.
		Inches.	*Ins.*		*Pounds.*	*Pounds*	*P. ct.*	*P. ct.*	*P. ct.*	
5580	Flat	6 by $\frac{7}{16}$	.8510	9.402	38,406	61,779	62.17	26.60	51.04	Silky.
	Round	$\frac{3}{4}$	.7480	10.700	41,530	62,690	66.25	24.30	57.60	Do.
	Difference	....	......	....	3,124	811	4.08	2.30	6.56	
5581	Flat	6 by $\frac{7}{16}$	.8456	9.462	38,892	61,573	63.16	27.20	47.09	Silky.
	Round	$\frac{3}{4}$	.7425	10.775	39,490	61,770	63.93	24.80	52.10	Do.
	Difference	....	......	....	598	197	.77	2.40	5.01	
5583	Flat	6 by $\frac{7}{16}$	.8449	9.470	45,090	68,120	66.20	24.75	55.05	Silky.
	Round	$\frac{3}{4}$	.7450	10.740	42,210	67,330	62.70	22.60	58.60	Do.
	Difference	....	......	....	2,880	790	3.50	2.15	3.55	
5585	Flat	6 by $\frac{7}{16}$	.8423	9.498	34,020	58,734	57.94	26.85	52.70	Silky.
	Round	$\frac{3}{4}$	.7475	10.700	43,860	62,330	70.38	25.90	47.50	Do.
	Difference	....	......	....	9,840	3,596	12.44	.95	5.20	
5586	Flat	6 by $\frac{7}{16}$	.8424	9.497	42,680	68,856	61.99	25.50	53.23	Silky.
	Round	$\frac{3}{4}$	.7420	10.780	41,620	67,070	62.05	24.80	46.70	Do.
	Difference	....	......	....	1,060	1,786	.06	.70	6.53	

AVERAGE.

[Exclusive of heat 5585.]

8	Flat	6 by $\frac{7}{16}$	......	9.490	41,880	65,026	64.41	25.75	52.20
8	Round	$\frac{3}{4}$	......	10.754	41,387	64,224	64.44	24.93	53.16
	Difference	....	......	....	493	802	......	.82	.96

The extreme case of the groove form giving much higher values tensile strength, and incidentally for final area, and the natural pr bility that these effects would follow a regular law, induced the B to make a series of experiments to determine the nature of the e of change of length. Accordingly, the part numbered 10 of anne plate 678 W, originally intended for the Chicago's boilers, and w had been cut up for other tests (p. 529), being considered suffici ly homogeneous, test pieces numbered 1 to 24, consecutively, were moved, as shown, Fig. 20, and variously shaped for test, the re being given in Table XXIII. Plate VIII. shows its graphic repre tation, in which the groove form is taken as the zero of length. final elongation for the groove form is obtained by subtracting u from the reciprocal of the ratio of fractured to original area and ing the decimal as per cent., and represents, therefore, the differe extension at the bottom of the groove. The dotted terminal line accordance with the experiments, but the results for final area in grooved form being in this case believed to be abnormal, the solid l show the results of an average of many tests in groove form from plate.

The curves show at a glance the nature and probable amount of ference in results from test pieces of various proportions in use boiler plate. Thus this plate tested by the United States Supervi Inspector would give about 63,000 pounds tensile strength and 50

reduction; tested for the Pennsylvania Railroad, it would show t 56,500 pounds, with 36 per cent. elongation; while, as tested under nspection, the result should be 55,700 pounds, with 27.9 per cent. ;ation. The difficulty of the steel manufacturer in working to such epant specifications is evident.

unexpected decrease of tensile strength for lengths greater than t 3 inches is a feature of the corresponding curve. The cause of s naturally looked for in the condition of the plate, but on referring g. 20, it is seen that while Nos. 17 and 18 are near the edge of the , Nos. 19 and 20 are in the center and adjacent to Nos. 3 and 4, and Nos. 23 and 24, the 10-inch lengths, are adjacent to Nos. 7 and 8, -inch lengths, the difference of tensile strength being 1,450 pounds. result requires corroboration before being accepted.

TABLE XXIII.—*Showing effect of length of test piece.*

ANNEALED BOILER PLATE OF CHESTER STEEL.

Original length between witness marks.	Number of piece.	Original width.	Original thickness.	Original sectional area.	Ultimate tensile strength per square inch.	Final elongation.	Final area.	Average tensile strength per square inch.	Average elongation.	Average final area.
Inches.		*Inches.*	*Ins*	*Sq. ins.*	*Pounds*	*Pr. ct.*	*Pr. ct.*	*Pounds.*	*Pr. ct.*	*Pr. ct.*
Groove	1	0.990	.660	.6534	63,330	41.0	47.0	63,065	40.5	46.0
	2	0.995	.660	.6567	62,800	40.0	45.0			
1½	3	0.990	.665	.6583	56,600	49.0	44.0	56,600	49.0	43.5
	4	0.990	.665	.6583	56,600	49.0	43.0			
2	5	1.021	.665	.6790	56,400	42.0	43.0	56,600	44.0	41.5
	6	1.021	.661	.6750	56,800	46.0	40.0			
2½	7	0.968	.668	.6466	56,200	40.0	39.0	56,200	40.0	40.0
	8	0.968	.668	.6466	56,200	40.0	41.0			
3	9	1.015	.660	.6700	56,400	38.0	39.0	56,400	38.0	39.5
	10	1.015	.660	.6700	56,400	38.0	40.0			
4	11	0.980	.655	.6420	56,300	34.0	39.0	56,200	34.5	38.0
	12	0.980	.660	.6470	56,100	35.0	37.0			
5	13	0.970	.650	.6300	56,300	33.0	37.0	56,445	33.0	37.0
	14	0.970	.650	.6300	56,590	33.0	37.0			
6	15	1.037	.650	.6740	55,700	29.0	36.7	55,700	29.5	36.9
	16	1.037	.647	.6710	55,700	30.0	37.0			
7	17	1.000	.645	.6450	56,000	28.5	39.0	56,250	28.5	39.5
	18	1.000	.642	.6420	56,500	28.5	40.0			
8	19	0.933	.664	.6195	55,200	27.4	40.0	55,200	27.9	38.5
	20	0.933	.664	.6195	55,200	28.4	37.0			
9	21	0.962	.655	.6301	56,000	28.0	35.0	55,955	26.6	36.4
	22	0.964	.653	.6295	55,910	25.1	37.8			
10	23	1.000	.663	.6630	54,750	27.8	37.7	54,750	27.4	36.8
	24	1.000	.663	.6630	54,750	27.0	36.0			

ENSILE TESTS BY INCREMENTS AND BY CONTINUOUS LOADS.

xt to the form of test piece, the subject most in dispute is the od of applying stress as regards time; that is, whether by regular ments at regular intervals or continuously at approximately uni- speed of ram or screw. It is claimed that in continuous testing time and power are saved and the capacity of the machine in int of work correspondingly increased, and this method is accord- the more generally used, especially in grading steel at the works, the Board has adopted the method of increments. As a matter ct, if anything like a complete record of each test is kept, the taken up in making the necessary calculations for the results of piece—which, to avoid error, should always be made before com- ing to strain the next—even with the various tables used as aids

to calculations, reduces the difference of time to a very small because in testing by increments much of this work can be do straining the piece. Thus, the modulus of elasticity, the elas ultimate tensile strength, and extension at tensile limit, ca recorded by the time the piece breaks, and there remain only measurements of elongation and fractured area and the quant pending on them.

But the cause of the original adoption of the method of inc was in order to obtain, as nearly as may be, uniformity in the of testing by different inspectors on different machines, in the of any conclusive information as to the effect of different me testing on the results. These considerations still hold, but the has been so far modified as to substitute for the five minutes strain one minute, or such other time as may be necessary to the initial extension, and, in order to obtain the principal elas regular increments are only to be applied beyond that stress.

As regards the effect on the results, it is believed that, in for this material under increasing stress, marked differences caused only by differences in the application of stress very m beyond the tensile limit. The following considerations lead opinion.

It would appear* that as regards capacity for sustaining beyond the elastic limit without increased distortion for a le the metals may be divided into two distinct classes: (1) the class, which will sustain a static load even near its ultimate for any length of time without increased distortion, and (2) th class, which undergoes a gradually increasing distortion under which are only a fraction of those required to break such metals The difference is due to the existence at such stresses in the lat of the quality of viscosity to a greater or less degree, and their a ultimate strength depends entirely upon the opportunity affo flow under the stress, and, therefore, upon the time of action of or each load in breaking by increments.

But it has been shown by Tresca that all sufficiently ductile m including steel, presumably harder than the mild quality unde eration, can be brought to the plastic or viscous condition by th application of stress, as illustrated in the cold drawing of le under compression. It is well known that in such a state the of such soft steels as we are considering is seriously affecte opportunity afforded for relief, by flow, of the internal strains p by drawing out either under compression or tension, for the p stresses are interchangeable in their effects upon plastic m Thus it is within the experience of all wire mills where testing that steel wire as fresh drawn is both weaker and less ductile t several months of rest.

We shall see when considering the extension diagrams (p. 50 that a condition of flow appears to be reached, probably in mo slightly before tensile limit in mild steel, to a varying extent ent heats, and, of course, with different degrees of hardness. accordingly appear that the conditions of straining from ju tensile limit up to rupture may slightly affect the apparent

* See papers before the American Society of Civil Engineers, by Prof. R. H. entitled, "Note on the Resistance of Materials, as Affected by Flow and of Distortion" (March 1, 1876), and "The Ratio of Set of Metals Subjected for Considerable Periods of Time." (December 6, 1876.)

ength and to a greater degree the contraction of area and that part the final extension which is due to the flow of the material while cking. We might expect to find that if, at this time, strain is brought by a series of jerks as in a common hand-hydraulic machine using ne pump, the material is not given time to flow, and the ultimate ten-le strength and final area will be higher and final elongation generally lower than with continuous and slowly applied strain. If, how, , the jerks are sufficiently rapid from the beginning, that element extension which consists of the more or less uniform extension over the whole length may be so much increased as actually to make the final elongation measured on the whole length greater, but the ultimate strength and final area will be larger as before. In ordinary testing the differences cannot be great, and many experiments are necessary to conclusively establish them, but it is seen that such differences as may be observed are probably due to the method of applying strain whether smoothly or by jerks, the ultimate strength and final area being increased by the latter method, provided the material does not exhibit viscosity much below tensile limit, when the time of absolute straining becomes important. The two essential elements of the elongation are differently affected and the combined action becomes one of difference, the figure being higher for very rapid or impulsive application, less for jerky action not sufficiently rapid to be reckoned impulsive, and higher again for smooth, slow application of strain.

Attention is called to the fact that stu ly of extension diagrams, such as those referred to, under these different conditions would throw probably considerable light on the subject, and also on the relative condition of viscosity of different pieces of metal.

It is conceivable, however, that the intrinsic nature of the material may be such that the effects of viscosity may appear for stresses considerably removed from tensile limit. Thus Commander L. A. Beardslee, U. S. N., has observed that one of the softest and most ductile specimens of chain iron tested by him at the Washington navy-yard exhibited a perceptible increase of resistance under rapid extension, as in the "tin" class.

If, indeed, the extension be very rapid or explosive from the beginning, it is conceivable that the time allowed for flow at any one point y be so small that the phenomenon of multiple necking, hereafter mennoned as occurring in as many as three places in a well-shaped piece of mild steel under slow test, may, so to speak, hold for all points, and the piece be drawn out or flow equally all along, thereby exhibiting a very great final extension, though, of course, with comparatively small contraction of area. This phenomenon, in fact, is reported by Col. E. Maitland, R. A., Superintendent of the Royal Gun Factory at Woolch, England, thus:* "Soft, untempered steel, having in the machine elongation of 30 per cent.,† had in the drop test an elongation of 38 or 40 per cent.; when tested by gunpowder, the elongation was 45 or 46 per cent.; and with gun-cotton, it actually rose to 60 per cent."

If the rapid or explosive force had been applied only after necking had begun, with appreciable local reduction of area, the effect would have been very different.

Table XXIV. gives the results of some tests made at the Chester Rolling Mills for information as to the effect of ordinary differences of time.

* See discussion on the paper on "The Adoption of Standard Forms of Test Pieces Bars and Plates."

† The elongations are for the short test pieces given in Table XIV. as in use at W ch Arsenal.

The slow tests were made by increments, in accordance with the general method pursued in this inspection. When tensile limit was approached, the machine was run slowly and steadily until fracture, the weights being adjusted so as to practically maintain a balance at all times. In the fast pull the same power was applied throughout, the rapidity of ram near and beyond tensile limit being greater than in the slow test. The results for ductility and final area are somewhat interfered with by laminations in one of the pieces broken by fast pull, the differences for ductility and final area being thereby increased. The results are illustrative of the conclusions above arrived at, the fast pull giving higher strength and less ductility with greater final area. The differences in the results of the slow tests with the grain from the original heat tests, as well as those in the two pieces for heat test, are suggestive of the lack of homogeneity commonly met with in plates.

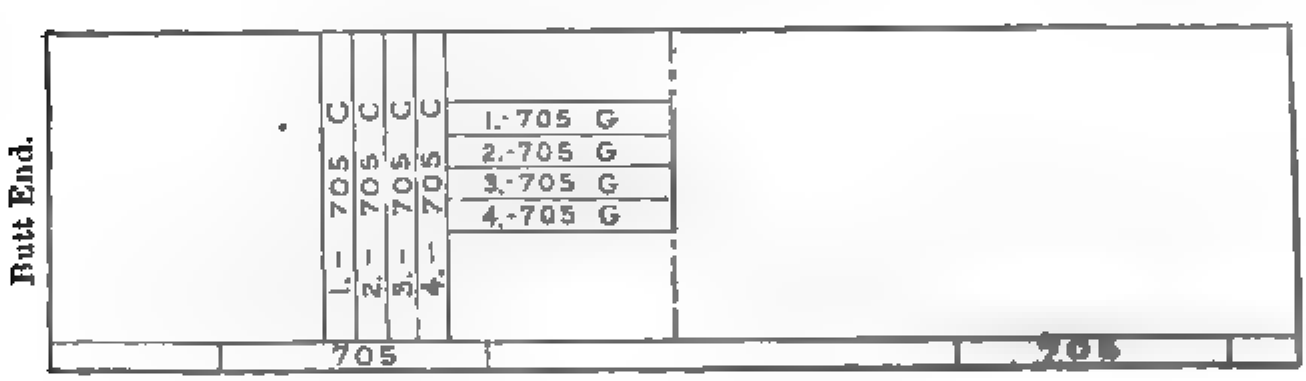
TABLE XXIV.—*Comparison of results of same material by fast and slow tensile tests.*

[Heat, 705; carbon, .16 per cent.; mang., .40 per cent.]

Marks.	Original width.	Original thickness.	Original area.	Ultimate tensile strength per square inch.	Final elongation.	Final area.	Time of test.	Average tensile strength per square inch.	Average final elongation.	Average final area.
	Inches.	*Inches.*	*Sq. ins.*	*Pounds*	*Per ct*	*Per ct.*	*m. s.*	*Pounds.*	*Per ct.*	*Per ct.*
ORIGINAL HEAT TEST.										
705	1.150	.530	.5909	60,750	25.00	51.00				
706	1.135	.535	.6072	62,580	25.70	48.00				
SLOW PULL, LENGTHWAYS.										
1.—705 G	1.011	.530	.5358	59,500	26.0	47.0				
2.—705 G	1.005	.530	.5326	59,300	28.0	47.0		59,400	27.0	47.0
FAST PULL, LENGTHWAYS.										
3.—705 G	1.048	.531	.5564	60,020	24.0	*53.0	2 30			
4.—705 G	1.010	.531	.5363	59,660	24.6	42.0	2 30	59,840	24.3	47.5

* Piece showed laminations in fracture.

Marks.	Original width.	Original thickness.	Original area.	Ultimate tensile strength per square inch.	Final elongation.	Final area.	Time of test.	Average tensile strength per square inch.	Average final elongation.	Average final area.
SLOW PULL, CROSSWAYS.										
1.—705 C	1.000	.528	.5280	59,090	22.3	47.0				
2.—705 C	1.045	.532	.5560	58,900	24.0	47.0		58,995	23.15	47.0
FAST PULL, CROSSWAYS.										
3.—705 C	1.022	.530	.5416	59,630	22.0	50.0	2 30			
4.—705 C	1.038	.530	.5501	59,080	21.5	54.0	2 30	59,355	21.75	52.0



	Ultimate tensile strength per square inch.	Final elongation.	Final area.
	Pounds.	*Per ct.*	*Per ct.*
Average heat test	61, 665	25. 35	49. 50
Average slow pull	59, 198	25. 08	47. 00
Average fast pull	59, 598	23. 03	49. 75
Difference fast over slow	+400	−2. 05	+2. 75

Table XXV. shows the mean results of some experiments presented by Mr. William Denny to the Institution of Naval Architects in 1880. The tests were made with a hydraulic machine.

TABLE XXV.

	Ultimate strength per square inch.	Elongation in 8 inches.	Time.
HARD STEEL.	*Pounds.*	*Per cent.*	*m. s.*
Mean of six experiments, plate ¼ inch thick	91, 011	11. 96	1 30
Mean of six experiments from same plate	89, 286	11. 48	11 50
SOFT STEEL.			
Mean of two experiments, plate ½ inch thick	65, 296	23. 55	1 30
Mean of two experiments from same plate	64, 176	23. 55	4 43
Do	64, 736	22. 7	13 11

It is seen that the very rapid testing gave higher results for ultimate strength and ductility, as would be expected. The contraction of area is not given, but was probably less in the rapid testing.

Table XXVI. gives the results of some experiments on steel similar to that for the cruisers, made at the Cambria Iron Works by Mr. C. A. Marshall, engineer of tests, and given in the discussion on Mr. P. G. Salom's paper before the American Institute of Mining Engineers, referred to on page 402. The conditions of tests are thus described:

Upon the point of time, I present tests of two heats of our steel, similar to that made for cruisers, with statement of speed and times from passing elastic limit to breaking. Specimens are alike throughout, being $\frac{7}{16}$ inches thick and planed to 1¼ inches width.

TABLE XXVI.

Heat number.	Elastic limit per square inch.	Ultimate strength per square inch.	Elongation in 8 inches.	Reduction.	Time.	Total time of test.
	Pounds.	*Pounds.*	*Per cent.*	*Per cent.*	*m. s.*	
5017	42, 080	65, 150	24. 8	47. 1	3 10	Say 7 minutes.
5017	41, 930	65, 550	25. 6	47. 1	3 10	Do.
5018	38, 450	61, 830	27. 2	50. 3	3 30	Say 7½ minutes.
5018	37, 870	61, 670	28. 5	50. 0	3 40	Do.
5017	42, 070	66, 450	26. 6	46. 8	14 0	22 minutes.
5017	42, 400	66, 530	26. 2	49. 3	13 0	23 minutes.
5018	38, 280	62, 410	28. 7	52. 0	11 0	19½ minutes.
5018	39, 000	62, 000	26. 3	48. 8	10 0	17½ minutes.

The speed of screw was throughout about ⅜ inch per minute. In the first four tests pulling was continuous after passing the elastic limit. The last four were tested in accordance with the requirements of the Naval Advisory Board. A strain of 30,000 pounds per square inch was left on for five minutes, elastic limit taken, and subsequent strain applied in increments at half-minute intervals.

The difference in tensile strengths in these tests may not be due altogether to the conditions of testing, but chiefly to difference of quality or physical condition. Thus, if we take the elastic limits as a measure of this condition, an artifice which we shall hereafter consider, and these values were obtained under identical circumstances in each case, and alter the figures for tensile strength proportionally so as to bring all the pieces of each heat to the same basis of elastic limit or assumed physical condition, we shall have the following averages without alteration in the values for elongation and reduction, which are apt to be affected by small differences of dimension as well as by the conditions of test:

TABLE XXVII.

Heat number.	Elastic limit taken as basis per square inch.	Corresponding ultimate strength per square inch.	Final elongation in 8 inches.	Reduction of area.	Time from elastic limit to rupture.		Total time of test.
	Pounds.	*Pounds.*	*Per cent.*	*Per cent.*	*m.*	*s.*	
5017	42,235	65,620	25.20	47.10	3	10	Say 7 minutes.
5018	38,640	62,525	27.85	50.15	3	35	Say 7½ minutes.
Average..	....	64,075	26.52	48.63	3	22	Say 7¼ minutes.
5017..........	42,235	66,490	26.4	48.05	13	30	22½ minutes.
5018..........	38,640	62,205	27.5	50.40	10	30	18½ minutes.
Average..	40,438	64,347	26.95	49.22	12	0	20½ minutes.

The average difference in tensile strength is now 270 pounds in favor of the increment testing, but while one heat gives a difference one way, the other reverses it. The real difference due to the manner of testing is probably inappreciable.

THE PHYSICAL AND CHEMICAL CONDITION OF THE TEST PIECE.

Another very prominent source of discrepancy in results from different pieces of material from the same heat is the difference in condition of the test pieces. These differences arise from four main causes, viz: (1) inequalities in the chemical composition of different parts of the same heat and especially of different parts of the same ingot; (2) inequalities in physical homogeneity in different parts of the ingot, arising from varying extent of liberation of occluded gases in cooling; (3) varying amount and nature of work of reduction from the ingot; (4) difference in heating and in the temperature of finishing, as well as all the conditions of cooling and subsequent treatment.

The first is due either to the irregular diffusion of manganese by being added to the charge too soon before tapping, a very rare occurrence now, or more generally to the phenomenon of hard centers or the segregation of the hardening elements to the center and top of the ingot during cooling. This latter condition is very generally prevalent to a greater or less extent, and sometimes very seriously so. It is promoted by very high temperature of cast and subsequent slow cooling, and is especially noticeable in Bessemer steel. It may easily affect the chemical results obtained from the same piece according to the depth of drilling and shape of point of drill, and give rise to very anomalous conclusions.

second source of discrepancy alters the physical homogeneity oint to point as the first does the chemical quality, and somewhat same manner, the top of the ingot, especially when top cast, be-ach more honeycombed than the bottom, and, although more ous near the sides of the ingot, the blow-holes are generally much and more injurious near the center.

effect of work of reduction at a heat is generally to increase both strength and ductility, the product of the two being considera-reased. If the material be originally much honeycombed as cast, ualities are much increased and the contraction of area likewise. is reason, a certain minimum amount of work of reduction is gen-onsidered necessary in order to obtain practical homogeneity of re, and for ship and boiler plate at least twenty reductions of ess are deemed necessary in most of the large steel works in Great . If the ingot be reduced in both width and thickness, or edged as in shapes or merchant steel and wire rod, less reduction is ble, and it is then reckoned as reduction in area of cross-section. conditions of heating undoubtedly affect the physical structure, he extreme of overheating to comparatively cold forging or roll-t the subject is too complex for treatment here. At whatever ature worked, the temperature at which the piece is finished lowed to cool off, together with the conditions of cooling, very ly affect the physical tests. Thus if a plate or flat cools, as is lly the case, in contact at various points with a cast-iron straight-plate, necessarily a good conductor, cooling is more rapid at the of contact and over the surface towards the plate, and initial are set up sufficient to warp the piece and even cause failure these strains are reversed in straightening or subsequent cold g, and this effect is greater the higher the temperature of finish-Another curious case is that of a deck beam which leaves the rolls ratively straight, but with bulb, web, and flange, all at different atures and therefore contracting unequally on cooling, as evi-by the considerable camber of the cold beam from the greater ction of the bulb, finished at the highest temperature. A very x, though regular, condition of strain must be set up, especially e fillets joining the web to bulb and flange.

n l these causes, widely differing results are easily obtained by experiments from material of the same heat, and it remains een if there is no basis to which the condition of the piece may uced. We shall consider this point more fully in studying the of carbon properties of the Cambria steel; it will suffice now to he principal points.

difference of chemical composition there can be no measure other ctual analyses of the test piece. Laminations, arising from blow-r other cause, will generally appear in the fracture and particu-ffect the contraction of area. The condition as to internal strain, parative annealing, arising from whatever cause, can probably sured for any known quality of metal by the elastic ratio or the hich the principal elastic limit bears to the ultimate tensile th. Thus if we have a large average of results for material of hemical quality, any departure from the average as to physical n, other than lack of homogeneity, will be fairly well indicated erence of elastic ratio from its average value. This proposition fairly well established later on, and its importance will be read-reciated.

STRAINING THE PIECE.

In placing the piece between the grips it is necessary that the line of resultant tensile resistance of the piece shall lie in the line of the resultant load producing stress, unless the cross-heads are held more rigidly than is usual. otherwise a cross-breaking is set up. The less ductile the material the more important it is that this condition may obtain. Thus if a filleted test piece of spring steel, taken from a bar of tapering thickness, be placed in an ordinary machine, centrally from edge to edge, its line of resultant tensile resistance may yet be so much out of center, on account of the unequal thicknesses at the two edges, that fracture will occur on the fillet where the sectional area is much larger than in the straight-sided portion. In such ductile material as mild steel for ships and boilers, the consequent effect would be very small or negligible, but in the less ductile materials it must be looked out for.

On the first application of stress the piece stretches in a more or less regular manner, the strain being proportional to the stress producing it. In short pieces of unannealed material this elastic extension as measured by electric contact instruments (see page 501) does not generally appear so regular as to produce a straight-line diagram, but lack of perfect straightness of test piece and the irregular hold of roughened grips under light load may produce apparent irregular extension or unequal distribution of stress, and consequent strain, in the cross-section, affecting the hold of the index arms. In fact, these considerations certainly prevent much reliance being placed upon individual results for modulus of elasticity obtained from short pieces, and would appear to make the average value too small. If, however, the modulus is desired, the piece must be straight—should have been perfectly straightened at the finishing heat at the rolls; cold straightening to any extent may affect the result. The stress for which the extension is to be noted must not be too near the principal elastic limit, generally about 10,000 pounds below its probable value, and the measuring apparatus, both for load and extension, must be both delicate and reliable. It is particularly necessary that the load should be uniformly maintained while the extension is measured, and there is consequent difficulty in obtaining consistent results on most of the hydraulic machines in use on account of leakage in the plunger packing or, more generally, in the pumps. Inasmuch as the elastic extensions are extremely small, a very valuable addition to such machines would be a valve of special design and workmanship, so as to be, and remain, perfectly tight, inserted between the cylinder and pumps, and an attachment to the main cylinder consisting of a small cylinder with screw piston, or otherwise designed, for producing small changes of volume or pressure. Such an attachment would also be of great value in determining the limit of elasticity.

After taking the readings for modulus of elasticity, a gradual increase of stress at length produces a slightly disproportionate extension, the corresponding value of the stress being taken as the limit of elasticity for such uses of the material as will permit of little or no permanent set in use, with comparatively high working loads, such as for ordnance and spring steels. For the mild steels used for structural purposes, we prefer to call this the *first* elastic limit, and it may be mentioned that its value may, to a certain extent, be affected by any lack of coincidence of the resultant lines of action of the load and of the tensile resistance. Further increase of stress causes a point to be reached where the extension

becomes entirely disproportionate, a very slight increase of stress pro- :ing an extension no longer requiring micrometric measurement to appreciated. This point we will call the *principal* elastic limit, and r structural steels it is the only one which need be taken into account. om this point the strain diagram, as ordinarily constructed (see page 3, *et seq.*), accurately represents the behavior of the material at the ic limit, frequently becoming nearly parallel to the axis of exten- ns. It is this feature which allows it to be easily obtained for the ıt steels under continuous test, because in a screw, or a tight hy- ılic, machine, the beam refuses to hold up the load, and, if the piece ıı retains a coating of mill-scale, which is usually the case in testing ates and shapes, the brittle scale commences to crack, generally near fillets. In the ordinary test of plates, where the test pieces are re ved by shearing, the effect of the bending on shearing and the su equent cold straightening may be such as to largely remove this peculiarity of the diagram by originally straining the material beyond its elastic limit.

The cracking of the scale on a mild steel test piece at and beyond the elastic limit illustrates the homogeneity of the material, for it proceeds in cross-lines on the surface, making, as nearly as may be, an an- e of 45° with the direction of tensile stress—the lines of maximum earing stress in a homogeneous material—and therefore, parallel or right angles to each other. The same thing may be even better seen the surface of the side in tension of a bar under transverse test; on compression side of such a bar the scaling takes place at right angles to the stress.

After a certain amount of stretching at the elastic limit, depending both on the chemical quality of the steel and its previous treatment (possibly also on the method of manufacture in the furnace), the relation between the stress and strain is shown by a line generally regular, concave to the axis of extensions, and of diminishing curvature, until, near the maximum load, the curve becomes very flat, rendering the extension at the highest point difficult to measure with accuracy. When this highest point is just reached the piece is said to be at the "point of failure," or at "tensile limit." The corresponding value of the ordi- ıte of the strain diagram is the "ultimate tensile strength," always the chief feature, and sometimes the only one, determined by the tensile test. This value is sometimes erroneously called the "breaking strain," but "breaking" would better apply to the load at fracture, and "strain," in scientific language, denotes the effect of the stress and not the stress itself.

Some experimenters, notably Sir William Fairbairn, have gone so far to consider the condition of the piece at "tensile limit" as final, at least for structural purposes, and confine their record to ultimate rength and extension at tensile limit. It has been urged that it denotes the extreme values to which the material can ever be strained, for any appreciable time, without rupture, and that the rivets would become seriously started in boilers and the skin-plating of ships causing excessive leakage. The difficulty of measuring the corresponding elon- ıtion with the necessary accuracy has as yet prevented requirements being based on the condition at tensile limit. Both at the Norway and Cambria Iron Works, the elongation at tensile limit was measured, giving values fairly uniformly below the final elongation (see Table IX. and). 455). The condition of the material at this point of failure is pecul- . The piece commences to heat up at the point where necking subquently occurs slightly before the maximum load is actually reached.

Also, after commencing to neck at one place, the piece sometimes strength there sufficiently to neck and actually break in another as many as three such neckings having been observed in well-s 8-inch pieces.

On passing the point of failure, the scale-beam drops and the load to the point of fracture continuously diminishes, the piece dr out or necking, generally over a short length, and fracture taking on a considerably reduced area in the mild steels. The metal i more or less plastic state, flowing like lead under pressure—not l under a constant stress, but with increasing resistance from unit of The amount of this increase of resistance, and an idea of its rate be obtained from Table XXXII. of tests made on the Rodman ma at the Washington Naval Arsenal, for comparison with the resu the same material on other testing machines. The average value resistance per square inch actual at tensile limit, for the represen pieces, is about 78,000 pounds, while at rupture it has risen to some over 110,000 pounds.

THE ELASTIC LIMIT.

No term expressive of physical quality of material has so confu meaning as elastic limit. Its original definition is that stress v slowly applied and removed, will produce no permanent disto The value obtained under this definition in actual testing is unce depending on the delicacy of the apparatus employed and wheth not the piece was originally perfectly straight and its section has uniformily strained, and requires great care on the part of the e menter. The same objections apply to the definition adopte Wertheim and several other physicists as the stress which pro a permanent elongation of .00005 of the original length. In c experiments on cold-rolled iron and steel, Thurston has adopted ferent *permissible* permanent set.* Such definitions are essen arbitrary.

The elastic limit is also sometimes understood to mean the which, although not causing fracture at once, will do so if repe sufficient number of times. Plainly, to obtain results under this tion is impossible in any system of commercial tests. Spange reasoning from his own and Wöhler's experiments, concludes th working strength of wrought iron is less than its elastic limit termined by first appreciable permanent set.

Styffe propounds a much more satisfactory definition thus: † " iron or steel bar be gradually extended by successive loads, wh first are so small that they occasion no perceptible permanent el tion, but are gradually increased, and are always allowed to opera as many minutes as each additional weight is per cent. of the load, then the author regards as the 'limit of elasticity' that lo which, when it has been operating by successive small incremen above described, there is produced an increase in the permanent el tion which bears a ratio to the length of the bar equal to .01 (proximates most nearly to .01) of the ratio which the increment of w bears to the total load." Although complicated in expression value so obtained is believed to be truly indicative of a definite q of the material. To obtain it in practice, the curve of permanent

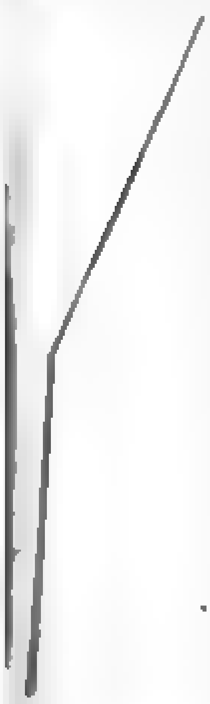
* On the Strength, &c., of Cold-Rolled Iron and Steel. Pamphlet, 8 vo., Pit 1878.

† Iron and Steel, by K. Styffe, translated by C. P. Sandberg, p. 30.

wn and the value corresponds to a certain inclination of its tangent almost invariably occurs at a point of great change in its ection. It is interesting to note that, at the limit so obtained, "the manent elongations begin to be so great that they become of prac- l importance;* and in bars which have not been freed from the le formed during annealing, the limit may be observed by the scale inning to peel off." It will be remembered that this differential ion of the scale cracking was successfully made use of in determin- the elastic limit at the Cambria Iron Works.

rom two of the above definitions based, one upon first appreciable per- nent set and the other on a distinct peculiarity in the curve of perma- t set, are derived two definitions applicable to the conditions of tinuous testing and in very general use. The first of these, ad- ced and used by Kirkaldy, may be defined as the stress beyond ich equal increments of stress cease to produce uniform increments tretch. It is evidently based upon the conception that the elastic ve is a straight line, or the strain directly proportional to the stress, that any departure from a uniform rate of extension under uniformly reasing stress must be caused by the production of permanent set. is assumption is by no means strictly correct even theoretically, ce recent determinations show that the elastic curve, although com- atively straight, is seldom perfectly so, its exact nature being newhat capricious, involving uncertain conditions of physical ucture and initial strains. Further, the point so determined is not nerally indicative of a sufficiently definite quality of material, and pears to be particularly affected by certain kinds of mechanical atment not materially affecting the other properties of the metal.

The second derived definition applicable to continuous testing is that ess at which the increase of extension becomes altogether dispropor- nate to the increase of stress. The corresponding feature of the ain diagram for ordinary wrought iron and steel is very marked, occur- ng as either a sudden change of direction without contra-flexure, as in g. *a*, or with contra-flexure, as in Fig. *b*.



g. a

It is interesting to state that of these, Thurston† considers the second indicative of lack of homogeneity across the direction of rolling, the blow-holes of the casting drawing out into long microscopic or less than microscopic capillary openings. The deduction is made by analogy from the diagrams produced by fibrous woods, such as locust and hickory. While very suggestive, it can scarcely be considered as established.

Where this peculiarity is marked, it is evident that the elastic limit so determined must agree very closely with that obtained from Styffe's definition, and is equally representative of a definite quality of the material. Comparatively cold finishing or cold aightening, and any lack of uniformity of the metal or in the trans-

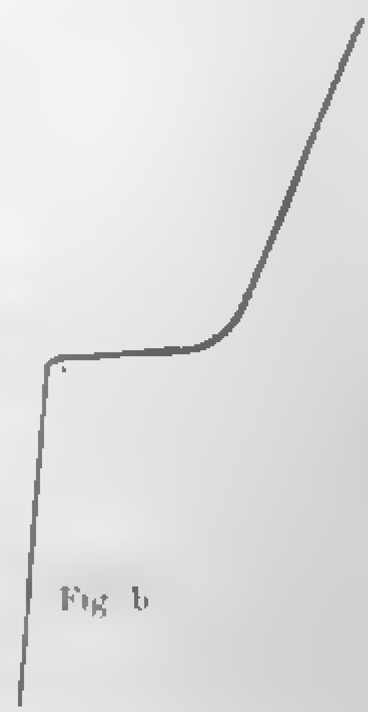


Fig b

* Presumably for metal to be used for structural purposes.

† Materials of Engineering, Part II, p. 531.

mission of stress to it, will affect the sharpness and extent of the irregularity. Graphitic carbon and high phosphorus would also appear to influence it.

It is evident that the altogether disproportionate extension at this point must cause adhering mill-scale of very low ductility to crack off; and, as previously remarked, in cracking it follows the lines of maximum distortion. The indication is of great value in commercial testing when the scale has not been removed in shaping the test piece, and indeed constitutes something of an argument in favor of using test pieces as nearly as possible in condition as finished at the rolls. A more generally observed indication depending on the same peculiarity of the strain diagram is the fact that, if the ram or screw of the testing-machine moves slowly and uniformly while the beam is kept balanced, at this point the beam will suddenly drop and will not lift again until the piece has been extended beyond the irregularity and increase of stress and of strain resume a normal proportion. For ordinary structural wrought iron and steel these two indications of the beam dropping and the scale cracking are generally sufficient to determine the elastic limit under this definition with great accuracy. The elastic limit determined from one or other or both of these indications, and which we will call the *principal elastic limit*, is that generally used for structural material in this country. In Great Britain, Kirkaldy's method is very generally adopted.

We have the means of comparing results for the same material un the three definitions most in use. Thus the Norway steel pieces Tables XXXI. and XXXII. gave an average for two pieces of 33,' pounds per square inch, or 53.5 per cent. of the ultimate strength, by the method of first appreciable permanent set at the Washington Naval Arsenal; 32,325 pounds per square inch, or 51.44 per cent. of the ultimate strength by the peculiarity of the strain diagram; and the inspector making the tests at the works and using Kirkaldy's method reports 26,190 pounds per square inch, or 41.67 per cent. of the ultimate strength. The need for the general adoption of some one or other definition is evident from these differences.

The difference between determinations under the first two of these definitions—first permanent set and peculiarity in the strain diagram—is not always in the same direction as above. In Table XXXI., the elastic limit for the pieces tested at the mills is as given by strain diagram; for those tested at Washington, the method of first permanent set was used. The Chester steel gives practically the same absolute value, but a greater ratio, by permanent set; the Norway steel is as above, both value and ratio greater by permanent set; one piece of Black Diamond steel showed abnormal results by permanent set, the other gave less value and ratio by permanent set; the Cambria steel gives much less value and ratio by permanent set, the average differences being 3,870 pounds per square inch and 5.18 per cent.

Adopting the principal elastic limit as that indicative of the proper quality for structural steel, examination of the above tables referred to shows that if a requirement for elastic limit were to be exacted, unless it were placed much lower than generally reckoned, the manufacture of some of the steels delivered would have to be radically changed. Thus, for the bridge steel (App., p. 577), the elastic ratio demanded for 80,000-pound compression metal is 62.5 per cent., and for 70,000-pound tension-metal 57.14 per cent., and it is very generally reckoned that ship-steel should give an elastic ratio of from 55 to 70 per cent., averaging somewhat above 60 per cent.

I gineers are now very generally of opinion that permissible working l is should be determined with reference to the elastic limit, having r rd to fluctuation of stress and the general duty required of the ce. Other qualities being equal, material of relatively high elastic it would therefore be desirable.

On the other hand, this can be carried too far. Steel can be made with gh elastic ratio by carrying too high phosphorus and keeping the r hardening elements and impurities as low as possible; but such ial, though it may give very fair results by ordinary tensile tests, is said be lacking in "body," will not stand much working or many heats, d is more liable to snap under sudden application, or fluctuation, of

ratively high elastic ratio for metal suitable for ship-building, when ished, cooled, and subsequently treated in a normal fashion, is to be ned generally in two ways, by carrying comparatively high phosrus with low silicon and by great amount of reduction or mechan work from the ingot. Opinions may differ on the first point for ons above stated; but for ship metal made by the open-hearth pro, with silicon not above .04 per cent., it would appear that the phosrus may be carried with advantage to very near the Bessemer limit .1 per cent.

Considerations of safety in working are generally those borne in mind controlling the amount of mechanical work necessary, but indirectly e elastic ratio is undoubtedly affected. The comparatively high ratio ckoned on for mild steel in Great Britain is largely due to the method manufacture, the reductions of thickness from the ingot rarely fall below 20, and much of it generally under the hammer. Kirkaldy,* perimenting on the open-hearth steel plate of the Steel Company of otland for the Board of Trade, obtains the following results of 48 tests under his definition:

Thickness of plate.	Mean elastic stress per square inch.		Mean ultimate stress per square inch.		Mean elastic ratio.	
	Lengthwise.	Crosswise.	Lengthwise.	Crosswise.	Lengthwise.	Crosswise.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Per cent.*	*Per cent.*
¼ inch	42,560	42,780	69,430	70,330	61	60
½ inch	35,390	35,170	64,730	64,060	54	55
¾ inch	35,390	34,940	66,080	65,180	53	53
1 inch	33,375	33,150	62,720	62,720	53	52
Total mean	36,510	36,510	65,630	65,410	55	55

It is seen that a difference of 8 per cent. of elastic ratio, or nearly 15 cent. of its mean value, exists between the 1-inch and the ¼-inch ate, and that the ratio rises continuously as the thickness diminishes and very rapidly below ½-inch thickness, owing, doubtless, to lower temperature of finishing and more rapid cooling. It is probable that the mean value of 55 per cent. under this definition would correspond to not less than from 60 to 62 under the definition commonly used in this country for structural material, and the difference is apt to be greater when the metal has been worked under the hammer.

The results of the Cambria steel well illustrate the general conclusions. Being made into shapes, the work of reduction was very great; little of t failed in the working, and none without evident cause; its average results on tensile test are perhaps rather better than those of the other

* Merchant Shipping Experiments on Steel, Parliamentary Paper, C. 2897, London, 1881.

steels; it was undoubtedly made cheaper; less was rejected on test; yet its phosphorus will probably average .085 per cent., and its average elastic ratio was about 64.5 per cent. Similar information is not available for the other steels, but 10 heats of Norway steel gave an elastic ratio of 53.74 per cent., while the average phosphorus is believed to be below .055. Recent heats of Chester steel are much higher in phosphorus than most of the steel delivered from these works, ranging from .057 to .1 per cent., as we think with advantage for the purpose to be served.

For boiler metal or ship-steel to stand flanging or hot working, the phosphorus should not generally exceed .06, the lower the better, and under ordinary methods of manufacture comparatively high phosphorus is not at all admissible for such material. On the other hand, a great increase in the work of reduction is highly advisable and may even be necessary for the thick plates used in marine boilers.

MODULUS OF ELASTICITY.

Within the elastic limit, the relation of stress and strain, is approximately that of direct proportion, being expressed by the simple equation $p=E\,e$, p being the stress, e the corresponding change of unit length in the line of force producing stress, and E a factor commonly called the modulus of elasticity, and evidently constituting a measure of stiffness or resistance to distortion. If $e=1$, $p=E$, or if it were possible without passing the limit of elasticity to double the original dimension under tension, the quantity E would be the stress necessary. For such materials as mild steel the measure of the stiffness is very great, and, under ordinary stresses, the corresponding extension is very small. The shorter the length strained, the more difficult is the exact measurement of the extension, so that in any system of commercial testing it is very difficult to obtain correct values of the modulus with the short pieces necessarily employed. In such cases, errors themselves very small may produce serious discrepancies in the results, and to avoid them much greater nicety in the construction and manipulation of instruments is required than can usually be obtained at steel works. Accordingly such determinations are generally reserved for the careful and exact tests of scientific experimenters.

Of late, however, attention is being directed extensively to the qualities of materials under stresses approximating to the working loads, which themselves are now based more frequently from consideration of elastic limit than, as formerly, of ultimate strength. In trussed structures, as roofs, and more especially bridges, the considerations governing the transmission of static stress from member to member, the strength of long columns or compression members, the development and transmission of internal oscillations, and the desirability of reducing deflection in many cases, would appear to be attracting attention especially to stiffness and elastic limit, so that requirements for the latter are very generally exacted, and for modulus of elasticity have been demanded (see Appendix p. 577.) In the determination of this very important quality, if only a satisfactory apparatus can be devised, the immense amount of material tested for commercial purposes affords means of investigating extreme values and the law of variation with reference to general quality and method of manufacture, such as cannot be obtained with the limited testing of specialists. Immediate point is given to this investigation at the present time by the facts that the wear of steel rails appears to be influenced by the intrinsic stiffness of the material, and the strength of long columns is very considerably dependent

ı this quality. The solution of the question as to the most suitable ıaterial for these purposes is evidently of the greatest importance.

Whatever apparatus be employed, the total error of determination 'ill be influenced by the straightness of the piece, its lack of homoeneity or the unequal transmission of stress from the grips to all parts f the section, the absolute length of the measured part, the stress seected for the observation of extension, and variations of temperature. 'he apparatus should be easily applied and removed, should read to he necessary degree of fineness, and its accuracy should not be influnced by the amount of stress to which the piece is subjected; it should :e account of lack of homogeneity or unequal transmission of stress, nd not be seriously influenced by changes of temperature in recording ts indications. Finally, it should not be too costly or liable to get out f order.

Numerous devices have been employed in this country, in general ither depending on delicacy of touch or of sight with the means of pro-ucing small motions, or on the enlargement, by levers or other means, f the small extensions to be measured. Having pointed out the needs f the case, it is unnecessary to describe them, as all are deficient in one r more points, and we will confine ourselves to the instrument used luring this inspection at the Cambria Iron Works, and which has been re generally used than any other, the Olsen electric-contact microm-:.

The micrometer consists of two frames, one to be secured to the up-er part of the piece and the other to the lower, the length between the ling screws being that adopted for test. The upper frame consists brass arm, A, with removable clamp piece B, both made with right-an bends at the center, being originally intended for squares and s. When flats are tested, the angle on the arm is filled by the inuon of a piece, as shown by the broken line. The frame is secured the piece by the screw C, set up tight against the piece, the reaction holding the clamp B against the milled-head screws D, which are adjustable to suit the thickness of the piece tested. Contact is therefore by the set-screw point on one side and considerable pressing area on the other. From the ends of the arm extend $\frac{3}{8}$-inch brass rods, carried by insulated gutta-percha sleeves *e*, and projecting above sufficiently for the insertion of wires to the battery. The lower part is similarly secured to the piece, but the arm is differently shaped, as shown, with broad split ends, in which work $\frac{3}{8}$-inch screws of the very best manufacture, 50 threads to the inch, with micrometer heads 2 inches in diameter, divided on the circumference into 200 equal parts. The micrometer circle is read in connection with the fixed scale, divided into fiftieths of an inch—the pitch of the screw. Reading to the nearest division of the micrometer head, therefore, the 0.0001-inch can be recorded, and the eye can determine the next place of decimals fairly accurately. An electric wire leads from the lower frame to an alarm bell in circuit with a battery and the rods of the upper frame. The apparatus being attached to the piece centrally and so that the set screws are the proper distance apart—determined by a shorter rod or scale of suitable length being just capable of insertion without pressure between surfaces of the clamp pieces—the screws are turned in succession l the point just touches the end of the insulated rod, contact being d by the ring of the bell, the corresponding readings are noted, and screws run down to avoid any pressure or contact due to tilting of arms as the piece is strained. The proper stress is then applied,

new readings taken, and the mean taken of the extensions note two screws.*

The trouble with this apparatus is the uncertain effect of the of the surfaces of frame and piece in contact as the one surf gates and the pressure between them diminishes. There is re believe that on the average this results in too great a value of tension, especially in filleted pieces, and a correspondingly lo for the modulus, the average defect in the steel tested at Joh being reckoned at about 300,000, or more. The lowest modulus r was 24,360,000, but as no special precautions were taken to h pieces perfectly straight, or any estimate made as to the effect of o curvature, this is not to be taken as reliable, the real minimum bly being considerably above this. The highest value for a h 31,475,000 (heat 4950, mean of two pieces), and the mean valu heats 27,720,000. From the observed defect of the micrometer a eral lack of perfect straightness of the pieces it is believed th value is too small by about 600,000, and it is probable that the v this steel varied from 26,000,000 to 31,500,000—rarely approach latter—with an average of 28,250,000.

As affected by the conditions of finishing and subsequent tre it appears that this steel cold-rolled has a modulus about 500,0 and annealed about 1,000,000 more, than in the average cond finishing at the rolls.

As affected by change of carbon, the curve of carbon p (Plate XXVI.) shows a slight rise, with increase of carbon, over t of tests. As the modulus closely follows the density of ma given nature, it is believed that it may reach a maximum value steel at from .30 to .35 per cent. of carbon, but must diminish w ther increase.

The modulus of elasticity of mild steel in compression is g taken the same as for tension. This was very closely true in so of shaft steel recently made on the Emery machine at the Wa Arsenal for this Board.

Mr. James Christie, from some recent experiments on Besse of structural quality,† gives the value of the modulus under c sion much less than under tension. Thus for 12 carbon stee tained for E in tension 27,030,000 to 32,780,000, with an avera of 30,135,000; while for compression the values were 15,13 24,490,000, with an average of 20,478,000. This result is ano and should be very carefully verified before being accepted.

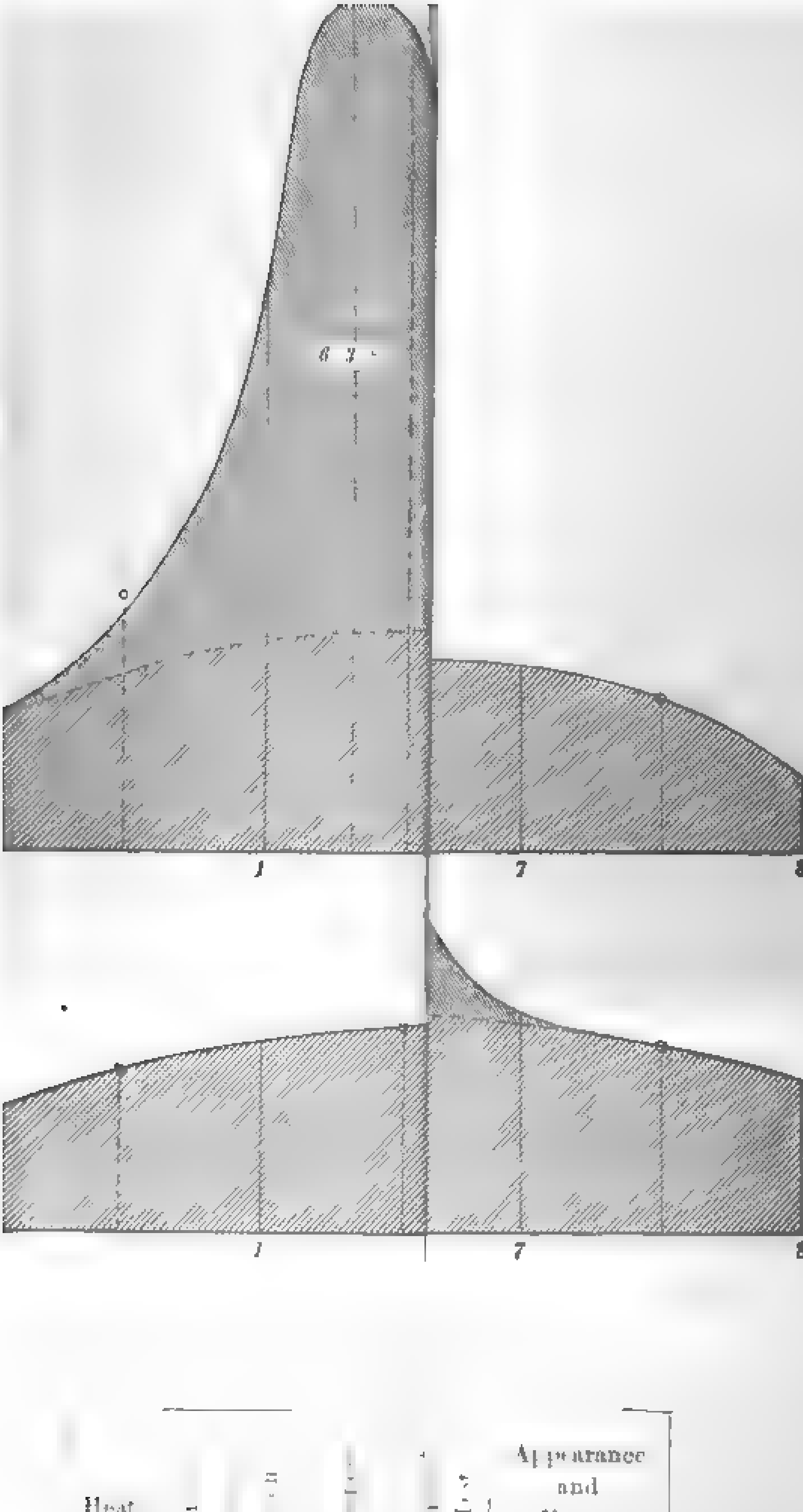
THE EXTENSION OF THE PIECE.

The total extension of the piece is made up of three eleme elastic extension, always a very small quantity; the extensio increasing load up to tensile limit, generally considered as fa form over the length, and constituting the most important par total extension; and the extension on flow or necking.

An idea of the disposition of the total extension along the together with the relative amounts of the two chief elements, obtained from Plates X., XI., and XII., extension diagrams for tw each of three heats of Cambria steel. Although selected at r both the quality of the heats and the behavior of individual pi

* Before affixing the micrometer to the piece a stress of about 8,000 poun square inch was very generally applied and removed, in order to tighten and remove initial strains, which sometimes seriously affect the very firs under low stress.

† Trans Am Soc Civil Engrs, Vol XIII



Piece 4.

Piece 1.

Heat	[illegible]	[illegible]	[illegible]	[illegible]	Appearance and Nature of Fracture.
[illegible]	1	[illegible]	[illegible]	15¼	Silky irregular
"	4	[illegible]	"	12½	" irreg'r-cup

Face page 502.

up on the fillet. It is perfectly evident that the effect of the fillet mus be always to slightly diminish the ductility if the piece is exactly inches long between fillets.

As has been remarked, the condition of the piece at tensile limit is considered final by some experimenters, and it has been proposed to base specifications accordingly.

For the representative steels in Table XXXII. the value of the extension after tensile limit is 4.54 per cent. in 8 inches, or 19.98 per cent. of the whole extension, for the Norway steel; 5.64 per cent. in 8 inches, or 21.63 per cent. of the whole extension, for the Cambria steel flat; 5.07 per cent. in 8 inches, or 22.94 per cent. of the whole extension, for the Black Diamond steel; 6.66 per cent. in 8 inches, or 26.28 per cent. of the whole extension, for the Chester steel; and 9.64 per cent. in 8 inches, or 31.43 per cent. of the whole extension, for the Cambria steel deck beam; the average value being 6.31 per cent. in 8 inches, or 24.45 per cent. of the whole extension; or, roughly, one-fifth to one-quarter of the total extension of an 8-inch piece occurs after tensile limit. The extension before tensile limit is much more uniform, being 18.18 per cent. for the Norway steel; 17.03 for the Black Diamond steel;* 18.68 per cent for the Chester steel; 20.38 per cent. for the Cambria flat, and 21.03 per cent. for the Cambria deck beam.

The average value of the extension at tensile limit for 23 accepted heats of Cambria steel given in Table IX. is 20.18 per cent. in 8 inches the corresponding average total extension being 25.3 per cent., whence the average value of the extension beyond tensile limit is 5.12 per cent in 8 inches, or 20.24 per cent. of the total extension.

Very similar results were obtained with the somewhat softer Norway steel, the average value of the extension at tensile limit for 30 heats given by Lieutenant Drake in his special report on proposed modifications of tests (p. 455) being 20.65 per cent. in 8 inches, with a corresponding average total extension of 26.81 per cent., whence the average value of the extension during necking is 6.16 per cent. in 8 inches, 22.98 per cent. of the total extension.

FRACTURE.

Rupture of the piece is accompanied by a sharp report, except when from some lack of homogeneity, it occurs by a tear from one point wi a dull thud. This suddenness prevents the action from being closely examined, but its nature is easily seen in breaking pieces punched or drilled in the center, which part more slowly. Rupture is then seen to occur by sliding action, or shearing on a quasi plane, or combination of planes, making a pretty definite angle with the direction of the straining force. course we speak of the mild steels as giving way in this fashion. The lack of homogeneity in puddled iron, due to the interposition of layers of slag, generally prevents this action from extending continuously across the piece, and breaks it up into such a large number of discontinuous and irregularly disposed facets of fracture, that the governing law is not apparent. Nevertheless specimens of pure well worked irons exhibit the tendency distinctly. The harder steels and iron do not rupture in this way, but with a square crystalline fracture The appearance of the fracture of the soft steels is largely due to the exact conditions of rupture. Thus, if the action be one of pure shearing, the fracture shows fine and silky, just as the hardest steel

* It is 18.76 per cent. for one piece of this steel, and the behavior of the other piece was somewhat abnormal.

show when sheared, and the same steel if necked and broken across suddenly will show a crystalline fracture of course. A crystalline fracture shows an essentially different action in breaking, and whether due to intrinsically different physical structure or to the conditions of fracture, it probably indicates the existence of variable resistance round any point in the metal.

The fracture of mild steel of good quality under tensile test is on a plane or planes making a more or less constant angle with the direction of the straining force. In rounds, as in rivet-bar, the cone of shearing is generally very perfect for some distance in from the edges, when it is topped by a collection of smaller facets lying across the section. An analogous section in flat bars is what is called a "cup" fracture, of equally inclined opposite planes from each wide side toward the central plane, with generally side or closing facets from the short sides of the section, like a ridge roof with end slopes. In flats the fracture is also frequently a continuous surface, nearly plane, across the thickness. Of the two kinds of fracture, the plane and the cup, the former probably denotes the greater homogeneity across the thickness of the metal. The larger number of fractures are distinctly one of these or a combination of the two. On the angles of fracture and the stresses producing rupture we shall have more to say later.

The thickness of the fracture in flat pieces is not uniform across the width, there being a considerable hollow towards the center of the fracture in the locally stretched part, the thickness being frequently 10 per cent. less than at the edges in the fractured area of pieces originally $1\frac{1}{2}$ inches by $\frac{7}{16}$ inch. The narrow side is also hollowed, but not appreciably.

The nature of the flow of the metal near the fracture is well illustrated in the opposite photographs of several samples of Chester steel by the position and arrangement of the originally equidistant scrive lines. It will be observed that the bowed cross-lines still cut the long lines at right-angles, and, since the density of the metal is found to be practically unaltered, the action is precisely similar to the flow of water in a smooth pipe of the form of the broken test piece.

MEASUREMENT OF FINAL ELONGATION.

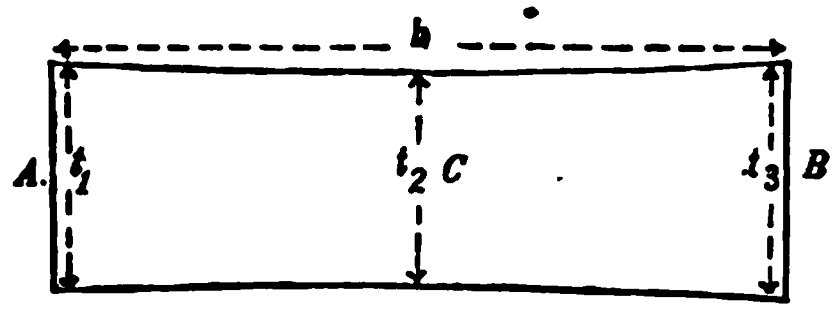
In making this measurement and that of final area, the use of forms to hold the two parts together when fitted saves time and promotes accuracy. The use of a direct vernier, such as described, p. 168, is also advisable as eliminating probability of error in subsequent division in rapid work. Care should be taken in removing the pieces from the machine to keep the fractured surfaces from striking anything, so that they will fit well. If the piece has torn from one point, the two parts will not be in a straight line when fitted as well as possible; in such a case they should be placed straight so as to touch at one edge, elongation measured, and the opening at the other measured and subtracted from the elongation before obtained.

MEASUREMENT OF FINAL AREA.

Some confusion has perhaps been caused by the use, in the records of tests, of the final area in per cent. of original area instead of reduction of area as commonly used in this country. The former is the more scientific function, has always to be obtained in order to get the latter, and amounts only to the substitution of a negative instead of a positive

scale of quality. The French call this quality the "striction" piece, and we have—

Striction = final area in per cent. of original area,
= 100 − reduction of area in per cent.



To measure the final area, the pieces should be fitted, the least width measured, and the thickness at each edge, and in the center in the plane of least width. On account of the hollow in the section it is necessary to introduce a formula for the mean thickness. This is best done by applying Simpson's rule for three ordinates. Thus, if t_1 t_2 t_3 be the thickness at A, C, and B, respectively, and b the least width, we shall have—

$$\text{Final area} = \frac{b}{6}(t_1 + 4t_2 + t_3)$$

The slight calculation necessary arranges itself easily in the note-book thus, taking piece 4908–2, Plate VI., as example:

t_1	= .30[illegible]
t_2 = .272	$4t_2$ = 1.08[illegible]
t_3	= .30[illegible]
	6)1.69[illegible]
Mean thickness	= .28[illegible]
Fractured width	= .93[illegible]
Fractured area	= .2[illegible]

On account of the curvature of the section, it will very much increase the accuracy of measurement if screw-gap gauges with round bearing surfaces are used.

As at present obtained, the fractured area is a very indefinite quality, few experimenters obtaining it in the same way.

At the Chester Rolling Mills, measurement for mean thickness was made half way from the center to one side on one-half of the piece.

At the Black Diamond Works, the mean of the thicknesses in the middle and at one side was taken. These both presuppose that the two edges will measure the same, which they will not generally do, but supposing $t_1 = t_3$, the error in mean thickness by the latter method is $\frac{t_1 - t_2}{6}$, or 1-6th the hollow of section.

At the Cambria Iron Works, the mean of the three thicknesses was taken as the mean thickness, the error being $\frac{t_1 - 2t_2 + t_3}{6}$, or one-third the mean hollow of the section.

At none could the pieces be measured as fitted together, one part only being measured, thus giving additionally high results for final area.

Identical and more correct methods will be used by all inspectors for any future work under the Board.

PROPORTIONATE REDUCTION OF WIDTH AND OF THICKNESS IN THE SECTION.

The reduction of area of a flat piece of rectangular section of greater width than thickness is not made up of equal reductions of width and of thickness, the reduction of the latter being invariably the greater. The proportion, with a given length of test piece, appears to depend upon the absolute size of the section and the ratio of its two dimensions. It may also be somewhat affected by the nature of the work of reduction in rolling. Table XXVIII. gives the results of numerous tests of Cambria steel in pieces 1¼ inches wide, of varying thicknesses, the ratio of width to thickness varying from 3.36 to 2,* and the diagram of Fig. 17 illustrates graphically the relation between the percentages of final width and final thicknesses. The curve terminates, of course, for a ratio of width to thickness of unity, or 100 per cent. The actual curve through four spots, by accident or otherwise, is a circle, and construction on ...aller scale shows its highest point to be 85.75 per cent. for a ratio of width to thickness of 8¼ to 1, or for a thickness of .15 inch in a piece 1¼ inches wide. The four special tests of Cambria steel in Table XXXII., for pieces 1.001 inches wide, sectional area .4727 square inches, and ratio of dimensions in original section 2.12, give an average of 91.47 per cent. for the ratio of final percentages of thickness and width. The dotted ...e through the corresponding spot is the probable curve for pieces ... inches long and 1 inch wide. The average value for all the tests in that table is 91.92 per cent., with about the same ratio of dimensions in the original section as for the Cambria steel.

The difference in surface of the width and of the thicknesses, the ...es being planed out on two sides only, may possibly influence the effect above considered.

FRACTURE BY SHEAR.

It has been stated that rupture of the mild steels generally occurs by a ...ng action, or shearing, on a quasi plane, or combination of planes, ...ing a pretty definite angle with the direction of the straining force. Frequently the surface of fracture is sufficiently defined to admit of fairly accurate measurement, and a number of fractures of Cambria steel were so measured and the results tabulated. The mean angle of the fractured surface with the straining force as so measured is not 45°, as it would be if the material were perfectly isotropic when rupture occurs. There is reason to believe that this material is practically isotropic under strains considerably above the elastic limit, and even perhaps approaching tensile limit, but during necking the action of the flow produces a stringing of particles, so that the surface of the piece treated with acids shows a kind of fiber. This fiber should not, however, be confused with that developed by good fibrous iron. The union of one fiber or line of particles with adjacent ones is much more complete in the steel, in which there is no slag interposing between the fibers, while the iron is never without it.

How far the lack of isotropic quality at rupture will affect the disposition of conjugate stresses is as yet impossible to say; from the bearing of the results of independent tests upon the conclusion to be arrived at from an investigation of the stress under which fracture occurs on the assumption of isotropism, the effect is probably small.

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* The six selected heats are 4674, 4678, 4681, 4682, 4684, 4686, the test plates for which were accidentally rolled too thick.

If P (Fig. 18) be the force producing principal stress (tensile) a moment of fracture; A_F, the fractured area measured at right a to the line of action of the force P; and φ the mean angle of the f ured area with the line of force, then the mean shearing stress o plane of fracture in a perfectly isotropic body will be given by

$$P_s = \frac{P}{2A_F} \sin 2\varphi, \text{ or } = \frac{P}{\frac{2A_F}{\sin 2\varphi}} \text{*}$$

Let A B C D (Fig. 19) be the fractured surface, approximately pl *a b c d*, the corresponding area—commonly called the fractured area right angles to the line of force producing stress; Φ, the compleme the angle between the two planes, or the angle of A B C D, with line of force.† The thicknesses *ad*, *bc*, on the edges, and *ef* at the mi of the fractured area are not equal, *ef* being especially less than other two on account of the invariable hollow of the section tow the center. The value also of the angle made by the line of force the edges AD and BC and with the corresponding center line EF is generally the same. So that the mean value of the function

$$\frac{2A_F}{\sin 2\varphi}$$

must be obtained by integrating over the surface.

Acordingly, let t_1, t_2, t_3 and φ_1, φ_2, φ_3 be the values of the thick and angle at G, I, and H, respectively; then, applying Simpson's for three ordinates, we have

$$\frac{2A_F}{\sin 2\varphi} = \frac{GH}{3}\left\{\frac{t_1}{\sin 2\varphi_1} + \frac{4t_2}{\sin 2\varphi_2} + \frac{t_3}{\sin 2\varphi_3}\right\}$$

and

$$P_s = \frac{P}{\frac{GH}{3}\left\{\frac{t_1}{\sin 2\varphi_1} + \frac{4t_2}{\sin 2\varphi_2} + \frac{t_3}{\sin 2\varphi_3}\right\}}$$

whence, by substituting the proper numerical values and perfor the operations indicated, the numerical value of the shearing stres der which rupture occurred can be obtained for any measured frac

An interesting derived function is the mean angle of fracture which is meant the angle which upon being inserted with the ordi fractured area in the function

$$\frac{2A_F}{\sin 2\varphi}$$

will give it the value obtained by integration.

The calculation in a particular case arranges itself as follows:

NUMERICAL EXAMPLE.

Piece 5221–2 in Table XXIX.

t_1 . . . . . . .329 log. = 9. 51720
$2\varphi_1$ . . 102° log. sin. = 9. 99040

9. 52680

* See any standard text-book on the strength of materials.

† It makes no difference which of the two angles is used, since the sine of twi angle is the same in either case.

Number corresponding = .33635......... × 1 = .33635

t_2.... .310 log. = 9.49136
$2\varphi_2$..110° log. sin. = 9.97299

9.51857

Number corresponding = .32990......... × 4 = 1.31960

t_3.... .330 log. = 9.51851
$2\varphi_3$..101° log. sin. = 9.99195

9.52656

Number corresponding = .33617......... × 1 = .33617

3)1.99212

.66404 log. = 9.82219
.973 log. = 9.98811

Corresponding co-log. = .18970..... Log. $\frac{2A_r}{\sin 2\varphi}$ 9.81030

P...31,000...log. = 4.49136

log. P_r = 4.68106
P_r = 47,980 pounds per square inch.

Mean angle.

Co-log. $\frac{2A_r}{\sin 2\varphi}$ = .18970
A_r... .3079 log. = 9.48841
2 log. = .30103

9.97914 corresponding to $2\varphi = 107°37'$, or $\varphi = 53° 48\frac{1}{2}'$

Table XXIX. gives the results* of the tests with measurements of fractured area and derived quantities. The measurements for thickness of fractured section will give a very fair idea of the amount of hollow commonly found with this proportion of test piece. The less thickness at center is generally accompanied by the greater angle with the line of force, in twelve cases out of the fourteen the angle at the center exceeding the mean for the edges, and in only three is it exceeded by the angle at any edge. The mean angle of the surface with the line of force is seen to vary from 49° 20′ to 61° 18′, a range of 12°, and its probable average value is 53° 40′. From the fact that the angle at the center exceeds the values at the edges, it is probable that the mean angle for round pieces, breaking with a cup fracture, will slightly exceed this value.

*In the calculation of these results the methods proposed in this report have been adopted, so that certain columns differ from those in the table of tests for this steel.

TABLE XXIX.—*Fracture by shear.*

Heat.	Mark.	Original section. Width.	Original section. Thickness.	Original section. Area.	Fractured section. Width.	Fractured section. Thickness at edges and middle.	Fractured section. Angle of surface at edges and middle with line of force.	Fractured section. Mean angle of surface with line of force.	Fractured section. Area.	Elastic limit per square inch.	Ultimate tensile strength per square inch.	Elastic ratio.	Final elongation.	Final width.	Mean final thickness.	Final area.	Modulus of elasticity.	Elongation at tensile limit.	Load at rupture. Per gauge.	Load at rupture. Per square inch of final area.	Shearing stress producing rupture on the area of fracture per square inch.	Ratio. Shearing stress divided by apparent tensile stress.
		Inch.	*Inch.*	*Sq. in.*	*Inch.*	*Inch.*	° ′	° ′	*Sq. in.*	*Pounds.*	*Pounds.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*		*Per ct.*	*Pounds.*	*Pounds.*	*Pounds.*	*Per ct.*
4879..	1	1.247	.436	.5437	.924	.310 .276 .307	58 15 53 45 55 15	53 58	.2650	38,440	62,730	61.28	25.7	74.10	65.79	48.74	29,610,000	20.9	29,080	109,440	52,080	82.99
4879..	2	1.246	.435	.5420	.952	.322 .266 .315	48 30 49 30 49 30	49 20	.2829	39,490	63,480	62.20	22.8	76.50	65.24	52.20	27,740,000	21.0	30,490	107,450	53,116	83.67
4879..	3	1.262	.431	.5439	.946	.310 .279 .306	50 00 58 15 50 00	53 16	.2731	40,450	63,430	63.77	26.8	74.96	66.98	50.20	26,230,000	22.2	30,400	111,310	53,974	84.93
4879..	4	1.261	.434	.5472	.938	.315 .283 .312	50 00 50 00 51 30	50 10½	.2750	40,200	63,770	63.04	28.4	74.36	67.55	50.25	27,900,000	22.0	29,600	107,650	52,914	82.97
4907..	3	1.287	.440	.5580	.978	.324 .313 .305	50 45 58 30 58 30	56 48	.3115	40,320	65,600	61.95	24.7	77.41	72.76	56.32	29,690,000	18.0	32,000	103,730	47,070	72.32
4908..	1	1.251	.417	.5217	.935	.310 .278 .305	52 10 54 45 50 00	53 41	.3001	38,340	62,560	61.35	27.0	74.74	69.61	51.58	28,130,000	20.0	28,000	104,050	49,654	79.45
4908..	3	1.264	.417	[illegible]	[illegible]	.300 .272 [illegible]	52 30 64 00 52 30	61 18	.2946	40,180	62,700	64.06	25.5	74.64	67.79	50.60	30,300,000	19.0	28,300	106,950	45,058	71.87
4908..	4	1.261	.415	.5191	.971	.310 .260 .295	55 45 59 20 58 00	57 50	.2848	40,400	62,920	64.30	26.60	78.62	69.28	51.01	33,000,000	22.0	27,000	101,950	45,960	73.05
4918..	2	1.243	[illegible]	.5440	.954	[illegible] .316 [illegible]	49 30 50 20 49 20	50 6	.3015	38,940	62,600	62.12	25.4	76.82	72.15	55.42	29,270,000	20.0	30,500	100,500	49,448	78.87
4918..	3	1.245	.437	.5441	.954	[illegible] [illegible] [illegible]	50 45 50 45 48 00	50 28½	.3153	40,070	63,050	63.55	24.0	76.63	75.62	57.95	29,590,000	19.0	30,600	97,060	47,678	75.00
4919..	2	1.245	.445	.5540	[illegible]	.340 .316 [illegible]	53 30 55 00 46 00	58 48	.3102	41,280	64,450	64.13	23.6	76.95	72.76	55.99	29,090,000	18.6	31,400	101,200	48,287	74.92

									[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	47,550	80.11
5221..	2	1.260	.443	.5582	.973	.323 .329 .310 .330	51 45 51 00 55 00 50 30	53 48½	.3079	38,696	62,254	62.16	24.0	77.22	71.45	55.17	27,746,000	......	31,000	100,680	47,980	77.09
Average by tests (14)								53 38	......	....	63,023	......	25.5	....	....	52.97	....	......	....	....	49,076	77.89
Average by heats (7)								53 42¼	......	....	62,830	......	25.24	....	....	53.80	....	......	....	....	48,342	77.00
Probable average								53 40	......	....	62,930	......	25.38	....	....	53.35	....	......	....	....	48,730	77.45

A curious counterpart of the fracture of mild steel by tension is foun in that of short pieces of cast iron by true compression. Hodgkinso experimenting on cast iron of the same manufacture in pieces of "leng not more than about three times the diameter," finds that "the streng for a given base is pretty nearly the same," and in gun metals with low graphitic carbon the value is about that of the final strength of the mild steel per square inch of fractured area, from 100,000 to 115,000 pounds per square inch, although the distortion in the cast iron is of course small. Fracture of such pieces of cast iron takes place either by wedges sliding off, or by top and bottom forming pyramids and forcing out the sides, of which we find analogues in the plane and cup fractures of mild steel. Further, the angle of the wedge is nearly constant, a mean for 21 cylinders being 55° 32′, very nearly the angle which we have obtained for the fracture of mild steel flat pieces, and still nearer the probable value for rounds. Thus, besides the disposition of conjugate stresses being similar but opposite, fracture occurring by shearing in both cases, the very close accord of the angle of fracture points to analogous structure with respect to the resistance offered to the opposite stresses of tension and compression for the mild steel and cast iron respectively.

For the average quality of the steel represented in Table XXIX. the shearing stress on the fractured area at rupture was 48,730 pounds, with an average ratio to the ultimate tensile stress of 77.45 per cent. An average has been taken by tests on account of the complex way in which the results for the fracture are obtained and consequent liability to individual error, and also by heats, without regard to the number of tests, in order to take into account the variation of intrinsic quality. The probable average has been taken between the two. If we consider the method of obtaining it as satisfactory, it should represent the resistance of the material to unsupported or theoretical shearing, that is, shearing uninfluenced by the method of applying the forces.

SHEARING STRENGTH OF RIVETS.

The shearing resistance of a rivet is seriously interfered with by the compression between the rivet and the bearing sides of the hole, the effect being to increase the shearing resistance offered per unit of area as the size of the rivet diminishes. Difference of quality between plate and rivet, proportion of thickness and diameter, and the sharpness of the edges of the hole, will also somewhat affect the shearing resistance. Under the ordinary conditions of ship and boiler work, the quality of plate and rivet being not very different—although the quality of the metal in the walls of the hole has frequently been affected by punching and insufficient riming—and the proportion of bearing and shearing areas being fairly uniform, it is known that the smaller rivets give considerably higher shearing resistance than larger ones of the same quality. The difference has, so far as we know, never been experimentally quantified, and it is believed that the following investigation will afford valuable information.

At the end of the tables of tests of rivets (pages 449 and 450) will be found the average ratio of shearing to tensile strength for each s tested. In combining the results of tests of ¾-inch rivets, at Pittsbur with those for the same size at Chester, a representative value will given to the former of double that due to the proportionate number of tests, inasmuch as they were carefully and independently obtained. In connection with the values so determined for the different sizes, we will

ably fairly correct below the elastic limit, at and beyond that point the method of clamping the index-arms to the piece with a considerable surface of contact seriously affects the readings, and it is believed that the irregularities shown by the spots are due rather to this defect in the micrometer * than to the behavior of the material. For this reason also the elastic limit determinations for these pieces are perhaps somewhat untrustworthy, and not as accurate as if simpler methods of measurement had been used.

Table XXXI. contains particulars of the tests with certain derived quantities. As gauged by the ultimate tensile strengths, the steels are seen to be directly comparable, and while the tests of each manufacture are too few to admit of strictly quantitative comparison, the principal points can be noted.

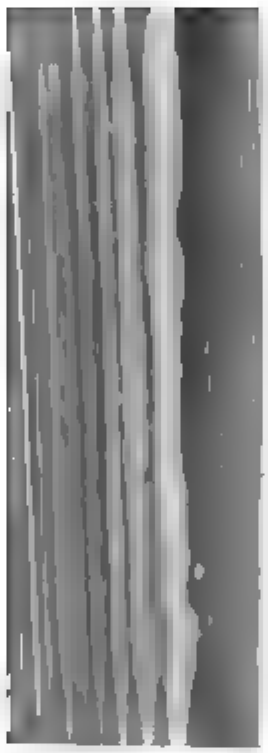
TABLE XXXI.—*Analysis of results of strain diagrams of special tensile tests.*

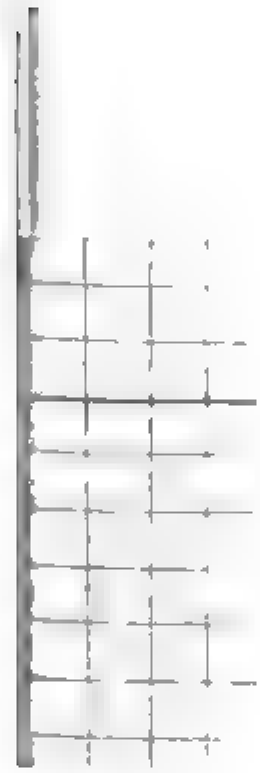
Marks.	Manufacturer.	Tested at—	Carbon.	Manganese.	Phosphorus.	Original width	Original thickness.	Original area.
			Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Inches.*	*Inches.*	*Sq. in.*
486-C	Chester Rolling Mills	Chester Rolling Mills.	*.12	*.37	....	1.000	.5060	.506
486-D	do	do	.12	.37	......	1.000	.5070	.507
36 U 1	Norway Steel and Iron Company.	Norway Steel and Iron Works.	*.16	*.36	......	.985	.4220	.416
36 U 3	do	do	.16	.36		.996	.4250	.423
P. S. 2.	Cambria Iron Company	Phœnix Iron Works.	.14	.336	.092	1.003	.5120	.513
P. S. 4	do	do	.16	....	.079	1.000	.5150	[illegible]
4823-1	do	Cambria Iron Works.	.19	.600	.065	1.003	.4270	
4823-2	do	do	......			1.003	.4290	
E. A. M. 1	Park Bro. & Co	Black Diamond Steel Works.	......	..	....	.996	.4620	
E. A. M. 2.	do	do	....	.....	.....	.997	.4750	.473

Marks.	Elastic limit.	Ultimate tensile strength.	Elastic ratio.	Final elongation	Final area.	Area of strain diagram.	Work required to break a bar of 1 square inch sectional area 8 inches long.	Ratio—Area str. diag. / Ult. T.S. × Elong.
	Lbs. per sq. in.	*Lbs. per sq. in.*	*Per ct.*	*Per ct.*	*Per ct.*	*Lbs., per ct.*	*Foot-lbs.*	*Per ct.*
486-C	31,600	63,930	49.43	24.40	56.70	(†)	....	.. ..
486-D	31,650	63,800	49.45	25.31	44.30	(†)	....	.....
36-U 1	32,500	63,460	51.21	27.50	....	1,571,600	10,473	90.1[illegible]
36 U 3	32,150	62,244	51.66	24.35	...	1,367,000	9,116	90.[illegible]
P. S. 2	38,800	63,770	60.84	24.94	56.40	1,429,200	9,528	‡89.[illegible]
P. S. 4	38,000	62,258	6[illegible].04	27.05	53.93	1,530,900	10,306	90.[illegible]
4823-1	42,500	63,590	66.84	26.40	49.60	1,513,600	10,092	90.1[illegible]
4823-2	44,000	63,470	69.32	24.40	51.50	1,412,400	9,416	91.[illegible]
E. A. M. 1	36,250	62,800	57.73	23.25	.....	(†)	....	.. ...
E. A. M. 2	39,000	64,370	60.59	26.40	.. ...	(†)	....	.. ..

* Heat determinations. † Strain diagram incomplete. ‡ Broke through flaw.

* This defect in the electric contact micrometer has been carefully remedied in a new instrument designed and in use by Mr. C. A. Marshall, engineer of tests, Cambria Iron Works, by using point bearings only to secure the gauge to the piece, the index-arms being steadied by springs with roller bearings against the piece. This new instrument is quite perfect.





Tables of stress and strain.

CAMBRIA SHIP STEEL.

ken from web of 8-inch deck beam. Tested on Riehlé machine
Measurements of strain taken with fine needle- and pencil-point

'iece P. S. 2.			Remarks.	Piece P. S. 4.			
lied re	Extensions.			Stress applied per square inch.	Extensions.		
.	*Inches.*	*Per ct.*		*Pounds.*	*Inches.*	*Per ct.*	
)00	(*)	(*)		10,000–18,000	(*)	(*)	
)00	(†)	(†)		20,000	(†)	(†)	
)00	(‡)	(‡)		20,000–36,000	(‡)	(‡)	
)00	.02	.25		38,000	.053	.66	L.
			38,800 pounds E. L.				
)00	.165	2.06		40,000	.170	2	
)00	.185	2.31		42,000	.217	2	
)00	.220	2.75		44,000	.252	3	
)00	.255	3.19		46,000	.286	3	
)00	.300	3.75		48,000	.320	4	
)00	.350	4.37		50,000	.375	4	
)00	.405	5.06		52,000	.427	5	
)00	.440	5.50		54,000	.530	6	
)00	.562	7.02		56,000	.633	7	
)00	.675	8.44		58,000	.750	9	
)00	.820	10.25		60,000	.920	11	
)00	1.085	13.56		62,000	1.224	15	
776	1.450	18.13	Ultimate strength.	62,258	....	...	
140	1.995	24.94	Final load and elongation.	....	2.164	27	

* Not appreciable. † First appreciable. ‡ Not accurately measurable.

Tables of stress and strain—Continued.

CAMBRIA SHIP STEEL.

[Pieces taken from 6 inches by $\frac{7}{8}$ inch flat. Tested on Gill machine at Cambria Iron Worl urements of strain up to stress of 56,000 pounds per square inch taken with Olsen electr micrometer.]

Piece 4823-1.

Stress applied per square inch.	Extensions.		Corresponding value of E.	Remarks.
Lbs.	*In.*	*Pr. ct.*		
10,000	.00280	....	28,570,000	
12,000	.00340	.....	28,240,000	
14,000	.00400	.....	28,000,000	
16,000	.00460	....	27,825,000	
18,000	.00515	......	27,960,000	
20,000	.00570	.....	28,070,000	
22,000	.00620	......	28,385,000	
24,000	.00680	......	28,235,000	
26,000	.00735	.....	28,295,000	
28,000	.00790	......	28,355,000	
30,000	.00845	0.106	28,400,000	
32,000	.00900	....	28,445,000	
34,000	.00955	...	28,480,000	
36,000	.01020	..	28,230,000	First E. L.
38,000	.01105		....	
40,000	.01380	0.173	......	
42,000	.01755	0.220	....	
				42,500 pounds E. L.
44,000	.09400	1.175	....	
46,000	.26565	3.321	....	
48,000	.41915	5.240	....	
50,000	.47725	5.966	....	
52,000	.51405	6.426	....	
54,000	.57420	7.180	....	
56,000	.65325	8.166	....	
58,000	......	8.700	....	
60,000	......	10.500	....	
62,000	......	.....	....	
63,590	....	20.50	....	Ultimate strength.
51,250	......	26.40	....	Final load and elongation.

Piece 4823-2.

Stress applied per square inch.	Extensions.		Corresponding value of E.	Rem
Lbs.	*In.*	*Pr. ct.*		
10,000	.00295	....	27,120,000	
12,000	.00350	...	27,425,000	
14,000	.00405	......	27,650,000	
16,000	.00460	......	27,830,000	
18,000	.00520	......	27,690,000	
20,000	.00575	......	27,825,000	
22,000	.00635	....	27,715,000	
24,000	.00700	....	27,430,000	
26,000	.00760	......	27,370,000	
28,000	.00820		27,320,000	
30,000	.00890	0.111	26,965,000	
32,000	.00965	......	26,525,000	First E. I
34,000	.01100	.....	24,725,000	
36,000	.01240	......	....	
38,000	.01445	....	....	
40,000	.01900	0.237	....	
42,000	.02765	0.346	....	
44,000	.04365	0.546	....	E. L.
46,000	.10670	1.334	....	
48,000	.27630	3.454	....	
50,000	.31690	3.961	....	
52,000	.35960	4.495	....	
54,000	.41885	5.236	....	
56,000	.48145	6.018	....	
58,000	......	8.700	....	
60,000	.....	10.500	....	
62,000	......	13.000	....	
63,470	......	20.25	....	Ultimate
53,250	......	24.40	....	Final load gation.

Tables of stress and strain—Continued.

CHESTER SHIP PLATE.

Tested on Riehlé machine at Chester Rolling Mills. Measurements micrometer gauge.]

Piece 486 C

Stress applied per square inch	Extensions.		Remarks.
Pounds.	*Inches.*	*Per ct.*	
10. 000			
13. 950			
21 [illegible]60			
25. [illegible]10			
29 765	02	25	
			31 600 pounds E. L.
33 715	07	87	
37 667	12	1 50	
41 620	16	2 00	
45. 572	23	2 87	
49 525	32	4 00	
53. 473	44	5. 50	
57. 425	61	7 62	
61 380	92	11 50	
63, 900			Ultimate strength.
	1 952	24. 40	Final elongation

Stress applied per square inch	Ext		
P[illegible]			
17			
[illegible]	02	25	
			31,550 pounds E. L.
33, 670	07	. 87	
37 615	12	1. 50	
41 555	17	2. 12	
45, 500	23	2. 87	
49, 450	31	3. 87	
53. 390	45	5 62	
57 335	. 62	7. 75	
61 280	93	11. 62	
63, 800			Ultimate strength.
	2. 025	25. 31	Final elongation.

Tables of stress and strain—Continued.

BLACK DIAMOND SHIP PLATE.

[Tested on Riehlé machine at Black Diamond Steel Works, Park, Bro. & Co. Measured length f elongations, 7.99 inches.]

Piece E. A. M. 1.

Stress applied per square inch.	Extensions.		Remarks.
Pounds.	*Inches.*	*Per ct.*	
10, 000–33, 000	(*)	(*)	
33, 333	.02	.25	
35, 420	.03	.38	
			36,250 pounds E. L.
37, 500	.15	1.88	
39, 590	.18	2.25	
41, 670	.21	2.63	
43, 750	.24	3.00	
45, 830	.28	3.50	
47, 920	.32	4.00	
50, 000	.37	4.63	
52, 080	.43	5.38	
54, 170	.50	6.25	
56, 250	.60	7.50	
58, 330	.71	8.88	
60, 420	.92	11.50	
62, 500	1.35	16.87	
62, 800	....	....	Ultimate strength.
....	1.86	23.25	Final elongation.

Piece E. A. M. 2.

Stress applied per square inch.	Extensions.		Remarks.
Pounds.	*Inches.*	*Per ct.*	
10, 000–33, 000	(*)	(*)	
33, 795	.02	.25	
35, 900	.03	.38	
38, 020	.04	.50	
			39,000 pounds E.
40, 130	.17	2.13	
42, 240	.20	2.50	
44, 350	.23	2.88	
46, 460	.25	3.13	
48, 580	.29	3.63	
50, 690	.33	4.13	
52, 800	.39	4.88	
54, 910	.47	5.88	
57, 030	.53	6.63	
59, 140	.66	8.25	
61, 250	.83	10.38	
63, 370	1.16	14.50	
63, 580	1.28	16.00	
63, 780	1.36	17.00	
63, 990	1.52	19.00	
64, 210	1.66	20.00	
64, 370	....	....	Ultimate streng
....	2.11	26.40	Final elongatio

* Not measurable.

Tables of stress and strain—Continued.

NORWAY SHIP PLATE.

[Tested on Riehlé machine at Norway Steel and Iron Works. Measurements taken with Brown & Sharp's micrometer gauge held to the piece. Measured length for elongation, piece 36 U 1 = 8.001; piece 36 U 3 = 8.002.]

Piece 36 U 1.				Piece 36 U 3.			
Stress applied per square inch.	Extensions.		Remarks.	Stress applied per square inch.	Extensions.		Remarks.
Pounds.	*Inches.*	*Per ct.*		*Pounds.*	*Inches.*	*Per ct.*	
10, 000	. 002	...		10, 000	. 001	......	
11, 923	. 003			12, 009	. 002	....	
13, 846	. 004	.		14, 018	. 003	....	
15, 769	. 006	.. .		16, 028	. 006	.. .	
17, 692	. 009			18, 037	. 006	.	
19, 615	. 011	. 14		20, 047	. 007	. 09	
21, 538	. 013	. 16		22, 056	. 008	. 10	
23, 461	. 014	. 17		24, 066	. 009	. 11	
25, 384	. 016	. 20		26, 075	. 011	. 14	
27, 307	. 021	. 26		28, 085	. 013	. 16	
29, 230	. 028	. 35		30, 004	. 016	. 20	
31, 153	. 032	. 40	32,500 pounds E. L.	32, 101	. 020	. 25	33,150 pounds E. L.
33, 076	. 046	. 58		34, 113	. 052	. 65	
35, 000	. 071	. 89		36, 122	. 086	1. 07	
36, 923	. 094	1. 18		38, 132	. 108	1. 35	
38, 846	. 114	1. 44		40, 141	. 134	1. 68	
40, 769	. 140	1. 75		42, 151	. 166	2. 08	
42, 692	. 168	2. 10		44, 160	. 196	2. 45	
44, 615	. 200	2. 50		46, 170	. 241	3. 01	
46, 538	. 241	3. 01		48, 179	. 284	3. 55	
48, 461	. 288	3. 60		50, 189	. 341	4. 26	
50, 384	. 335	4. 19		52, 198	. 404	5. 05	
52, 307	. 389	4. 86		54, 209	. 479	5. 99	
54, 230	. 469	5. 86		56, 217	. 583	7. 28	
56, 153	. 572	7. 15		58, 226	. 748	9. 35	
58, 076	* . 613	† 7. 65		60, 236	. 943	11. 79	
60, 000	. 892	11. 15		62, 244	1. 624	20. 30	Ultimate strength.
61, 923	1. 294	16. 17		52, 009	1. 948	24. 35	Final load and elongation.
63, 460	1. 898	23. 72	Ultimate strength.				
52, 384	2. 200	27. 50	Final load and elongation.				

* .718 probably. † 8.90 probably.

TESTS FOR COMPARISON OF MACHINES.

The tests made on the Rodman machine at the Washington Nav senal in accordance with section 12, Detailed Instructions, while plying much interesting information, are of little use for the pu intended. From some misunderstanding as to the instructions were not made in the same way as the corresponding tests at the v but after the ordinary method of testing adopted there for ord metal. The elastic limit was determined by successive applicatio removal of stress, noting the first permanent set; thence contin to tensile limit where elongation and resisting area are measure Table XXXII. of these tests, a derived column is given of what be the volume of the piece at this point if the resisting area wer form all along the piece and equal to that measured. Low perce of volume shows unequal extension, and corresponding contract area, along the length, and such lack of uniformity is noticeable Norway pieces and especially in one piece of Black Diamond which also gives extremely low elastic limit. Such results, with shaped pieces, show lack of homogeneous quality of the metal. curious and suggestive fact that the values of the percentage o ume at tensile limit follow exactly the order of final elongation, a somewhat to the argument as to the finality of the condition o piece at tensile limit. At rupture the stress was noted, and no standing the varying ductilities and contractions of area, the stre square inch of actual area is seen to be very uniform. The thickn final area was taken as the mean of three measurements, one at edge and at the middle. The other leading features derived fro table are referred to under appropriate headings.

TABLE XXXII.—*Tests for comparison of machines made on Rodman machine at the Washington Naval Arsenal.*

Marks.	Manufacturer	Carbon	Manganese.	Phosphorus.	Original width.	Original thickness.	Original area.	Elastic limit per square inch.*	Elastic ratio.	Tensile strength. On original area per square inch	Tensile strength. On actual area at tensile limit per square inch	Distortion at tensile limit. Elongation in 8 inches.	Distortion at tensile limit. Resisting area.	Distortion at tensile limit. Corresponding product for volume.	Stress at rupture. On original area per square inch.	Stress at rupture. On actual fractured area per square inch	Final elongation.	Final width of original width	Final thickness of original thickness.	Final area of original area.	Remarks.
		p. c.	p. c.	p. c.	inch.	in.	sq. in.	lbs.	per ct.	lbs.	lbs.	per ct.	per ct.	per ct.	lbs.	lbs.	per ct.	per ct.	per ct.	per ct.	
G. 0	Chester Rolling Mills	.12	.37		1.005	.507	.5095	30,714	50.64	60,650	75,630	18.95	80.20	95.38	49,250	111,030	25.17	69.65	63.51	44.36	
G. 1	do	.12	.37		1.004	.510	.5120	32,530	53.45	60,845	74,270	18.40	81.94	97.01	50,485	108,020	25.50	70.31	66.47	46.74	
D. O. 86 U. 2	Norway Steel and Iron Company.	.16	.36		.995	.422	.4198	33,104	52.65	62,890	81,320	16.47	77.34	91.61	52,210	110,970	22.62	72.37	66.59	48.10	
D. I. 86 U. 4	....do	.16	.36	..	.990	.421	.4167	34,310	54.36	63,115	79,340	17.89	79.56	93.79	62,790	111,470	22.82	71.73	66.03	47.37	
E. A. M. 3 O.	Park, Brother & Co			...	1.000	.480	.4890	34,667	56.45	61,765	78,010	16.76	79.18	94.03	51,120	108,470	25.06	71.80	65.64	47.13	Stress of 36,175 pounds per square inch remained on for 2 hours.
E. A. M. 4 I.	......do				.999	.491	.4905	25,690	40.76	63,025	81,905	15.31	76.87	88.63	53,00[illegible]	108,360	19.13	72.78	67.22	48.91	
G. D. 1, No. 1	Cambria Iron Company	.15	.39	.080	1.000	.510	.5100	34,470	56.04	60,855	74,130	20.05	82.10	98.55	48,070	114,540	29.84	68.10	61.64	41.96	
G. D. 2, No. 2	....do	.15	.39	.080	.998	.516	.5150	35,245	58.55	60,200	75,120	22.01	80.14	97.77	47,000	112,400	32.00	67.84	61.64	41.81	
B. 4623-1	....do	.19	.600	.055	1.006	.429	.4316	30,625	62.64	63,200	81,130	21.56	77.98	94.77	49,825	112,550	26.88	70.08	63.17	44.27	
B. 4623-2	....do	.19	.600	.055	1.002	.428	.4288	38,485	59.47	64,720	78,790	19.20	82.15	97.91	50,270	108,650	25.25	70.96	66.36	46.69	

* First elastic limit, corresponding to first appreciable permanent set.

Table XXXIII. is a comparison of results on the different testi chines with those on the Rodman, two tests for each steel on each two machines compared. On account of the difference of methods ing and the absence of comparative strain diagrams, no nice co sons can be attempted. On the basis of ultimate tensile stren Norway and Cambria machines give practically the same results Rodman; all the others read too high. But a comparison of duc and efficiency numbers obtained shows such variation in some c to throw serious doubts on the value of any comparison, while ill ing the necessity of a standard method of making the test. Th remarkable differences are the diminished ductility of the Norwa and the increased ductility of the Cambria metal from the Phœni Works in the tests on the Rodman. The reduction of efficiency ber of the one is about equal to the increase for the other, so tha steels were affected in exactly opposite ways by the difference of r in testing.

It may be safely stated that none of the machines differ suffi from the standard Rodman for the difference to be detected such method of comparison, and dead-weight test will alone sho differences as can ordinarily be expected to exist.

TABLE XXXIII.—*Comparative tensile tests of the same material on the machine at the works and on the standard Rodman.*

Manufacturer.	Tested at—	Testing-machine.	Carbon.	Manganese.	Phosphorus.	Original width.	Original thickness.	Original area.	Elastic limit per square inch.	Ultimate tensile strength per square inch.	Elastic ratio.	Final elongation.	Final area.	Efficiency number.
			Per ct.	*Per ct.*	*Per ct.*	*Inch.*	*Inch.*	*Sq. in.*	*Pounds.*	*Pounds*	*Per ct.*	*Per ct.*	*Per ct.*	
Chester Rolling Mills	Chester Rolling Mills	Riehlé, 100,000 pounds	.12	.37	.....	1.000	.5065	.5065	31,575	63,865	49.45	24.86	50.50	1,587,300
Do	Washington	Rodman	.12	.37	.....	1.005	.5085	.5108	*31,617	60,748	52.05	25.34	45.55	1,538,950
Norway Steel and Iron Company.	Norway Steel and Iron Works.	Riehlé, 50,000 pounds	.16	.36	.....	.991	.4235	.4195	32,325	62,852	51.44	25.93	.....	1,630,250
Do	Washington	Rodman	.16	.36	.....	.992	.4215	.4183	*33,707	63,003	53.50	22.72	47.78	1,431,350
Park, Brother & Co	Black Diamond Steel Works.	Riehlé, 50,000 pounds	.....	.....	.....	.996	.4785	.4767	37,625	63,585	59.16	24.83	.....	1,379,600
Do	Washington	Rodman	.....	.....		1.000	.4900	.4898	*30,278	62,395	48.60	22.10	48.02	1,377,300
Cambria Iron Company	Phœnix Iron Works	Riehlé, 150,000 pounds	.15	.39	.08	1.001	.5138	.5145	38,400	63,017	60.94	26.00	55.16	1,637,150
Do	Washington	Rodman	.15	.39	.08	.999	.5160	.5155	*34,852	60,528	57.59	30.67	41.89	1,855,900
Do	Cambria Iron Works	Gill, 100,000 pounds	.19	.60	.055	1.003	.4280	.4298	43,250	63,530	68.08	25.40	50.55	1,613,650
Do	Washington	Rodman	.19	.60	.055	1.004	.4285	.4302	*39,055	63,990	61.06	26.06	45.48	1,667,250

* First elastic limit, corresponding to first appreciable permanent set.

ANNEALING.

The Board's experience with annealing has been of a contrac nature; still it throws some light on the subject and introduces important facts as to the possible effect of the process as com carried out. The process of annealing boiler-plate at the work sists in slowly heating the plates in batches in large furnace cherry-red temperature,* and allowing them to cool slowly on th floor of the foundry, usually under a layer of ashes. Ordinary p tions are taken to insure uniform heating and subsequent cooling parts of the plate, and to avoid all possibility of overheating i part.

During the ordinary inspection, certain heats were annealed or in part, either to bring up deficient ductility in metal intend ship plate or to lower the tensile strength of metal just above th for boiler material. Table XXXIV. gives the corresponding res tests, from which it appears that the average effect on the Cheste is a reduction of about 5 and 19 per cent., respectively, in the or values for tensile strength and final area, and an increase of 12 cent. in the original value for ductility in 8 inches, the average or area being practically identical for both conditions. The very c erable decrease in final area will account for much of the incre final elongation, leaving that element of extension which is prac uniform along the length approximately unchanged. We have considerable diminution of tensile strength and increase of capac local distortion. It will be observed also that, roughly speaking changes are greatest in those heats which originally appeare softest. Especially noticeable is heat 640, soft and not annealed fo defect of quality. The increase of efficiency number in all excep heat should be a measure of the improvement effected by the pr provided there has been no essential molecular change. In he this number remains practically the same.

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* To make annealing thoroughly effective in removing internal strains, th perature should not be less than that at which the plate was finished.

TABLE XXXIV.—*Showing effect of annealing various heats of steel.*

CHESTER STEEL.

Heat.	Condition	Carbon	Manganese	Phosphorus	Original width	Original thickness	Original area	Ultimate tensile strength per square inch	Final elongation	Efficiency number	Final area.	Number of tests.	Decrease in tensile strength. Per square inch.	Decrease in tensile strength. Original value	Increase in final elongation. In 8 inches.	Increase in final elongation. Original value	Decrease in final area. Original area	Decrease in final area. Original value
		Per ct	Per ct	Per ct.	Inches.	Inches	Sq. in.	Pounds	Per ct.		Per ct.		Pounds	Per ct	Per ct	Per ct.	Per ct	Per ct
463	Unannealed				1.212	4840	5859	65.383	22.40	1,464,500	51.85	2						
	Annealed				1.230	4965	6112	64.350	23.00	1,480,000	46.70	2	1,033	1.58	0.60	2.68	5.15	9.93
619	Unannealed	16	36	059	1.170	6090	7018	63,067	25.70	1,620,700	50.67	3						
	Annealed				.985	7275	7161	59,250	28.35	1,679,400	44.10	2	3,817	6.05	2.65	10.31	15.57	20.40
640	Unannealed	13	30	.049	1.258	4900	6162	59,000	28.05	1,654,700	49.60	2						
	Annealed				724	7413	5302	54,620	30.25	1,652,000	36.75	4	4,380	7.42	2.20	7.84	12.65	25.91
660	Unannealed	16	.31		1.236	4890	6044	66.500	19.95	1,326,600	59.00	2						
	Annealed				1.182	5293	6256	63,617	24.57	1,563,000	49.67	3	2,883	4.34	4.62	23.16	9.33	15.81
664	Unannealed	13	32		1.194	.5000	5968	63,800	24.85	1,585,300	48.05	2						
	Annealed				.744	7198	5355	60,318	29.48	1,778,000	38.25	4	3,483	5.46	4.63	18.63	7.80	16.94
	Average												3,119	5.17	2.94	12.62	10.14	18.94

BLACK DL.

Heat.	Condition	Carbon	Manganese	Phosphorus	Original width	Original thickness	Original area	Ultimate tensile strength per square inch	Final elongation	Efficiency number	Final area.	Number of tests.	Decrease in tensile strength. Per square inch.	Decrease in tensile strength. Original value	Increase in final elongation. In 8 inches.	Increase in final elongation. Original value	Decrease in final area. Original area	Decrease in final area. Original value
					1.264	.4180	.5280					4						
					1.225	.4356	.5870					4	3,250	4.80	3.68	16.11	6.50	12.06

TABLE XXXV.—*Showing effect of annealing certain plates intended for Chicago's boilers.*

Heat.	Original heat tests. Carbon.	Manganese.	Original width.	Original thickness.	Original area.	Ultimate tensile strength per square inch.	Final elongation	Final area.	Plate.	Annealed plates. Original width.	Original thickness.	Original area.	Ultimate tensile strength per square inch.	Final elongation.	Final area.	Differences. Decrease of tensile strength per square inch.	Increase of final elongation in 8 inches.	Decrease of final area in per cent. of original area.
	Per ct.	*Per ct.*	*Inch*	*Inch.*	*Sq inch.*	*Pounds.*	*Per ct*	*Per ct.*		*Inch.*	*Inch.*	*Sq.inch*	*Pounds.*	*Per ct.*	*Per ct*	*Pounds*	*Per ct.*	*Per ct*
									671—O.	1.035	.657	.6790	54,000	27.0	36.0			
									671—O.	1.025	.662	.6795	53,100	27.2	34.0			
671	.13	.31	1.213	.482	.5846	61,600	30.0	42.0	671—F.	1.143	.617	.7052	53,170	29.8	38.5			
			1.200	.482	.5784	62,400	25.9	47.0	671—F.	1.190	.617	.7342	52,700	29.6	37.7	8,100	1.10	7.85
									671—Q.	.932	.580	.5405	56,400	28.4	35.7			
									671—Q.	1.020	.585	.5967	54,130	32.1	38.0			
									673—R.	1.064	.587	.6245	54,400	32.0	37.1			
									673—R.	1.050	.580	.6090	55,000	28.7	39.3			
673	.14	.33	1.093	.495	.5410	60,400	32.0	42.0	673—T.	1.036	.560	.5796	57,400	30.7	35.8			
			1.088	.495	.5385	60,500	28.5	40.0	673—T.	1.040	.565	.5876	53,600	31.0	38.7	5,617	—.02	3.02
									673—U.	1.020	.600	.6120	53,900	28.3	37.7			
									673—U.	1.015	.600	.6090	53,500	30.7	39.2			
									675—S.	1.038	.575	.5968	54,970	28.4	38.0			
675	.11	.29	1.228	.550	.6754	60,500	31.0	46.0	675—S.	1.038	.573	.5947	54,640	27.6	38.8			
			1.225	.550	.6738	58,900	28.3	41.0	675—X.	1.015	.595	.6039	53,020	30.5	35.0	5,567	—.57	2.80
									675—X.	1.175	.575	.6756	54,300	29.8	39.0			
									678—N.	1.040	.600	.6240	53,000	29.5	36.5			
678	.19	.32	1.230	.491	.6050	61,000	30.0	45.5	678—N.	1.040	.600	.6240	52,750	30.7	38.3			
			1.224	.495	.6060	58,400	26.6	43.0	678—W.	1.155	.615	.7103	53,500	29.3	42.8	7,237	—.75	5.30
									678—W.	1.135	.620	.6975	53,630	28.7	36.7			
Average of four heats						60,550	29.54	42.44	Average							6,080	—.06	4.75

ngle annealed heat of Black Diamond steel shows results very o the average for the Chester metal.

n sheets in the externally fired boilers of the Chicago besides the shell stresses are exposed to the action of the flame, so that ›emed advisable to careneal them. The heat he unannealed condition n very excellent—from ›ounds, with 29.65 per etch (efficiency number ›) to 62,000 pounds with · cent. stretch (efficiency l,732,900)—so that there amply sufficient margin e strength to allow for g. The test pieces were ı the side of each plate led with it. The results ›orresponding tests are with the original heat able XXXV. The aver›f tensile strength, 6,680 ·ery much exceeded what ›e expected, and, while nied by considerable on of final area, the final ›n remains practically ed, so that the percentıiform stretch along the ıas been probably di. The average efficiency will be found to have diminished. The anhad effected a radical n the material, and so the tensile strength that s could not be used.

ocess has not even proniformity in the same 73—T showing 3,800 difference between the . It was accordingly dexamine what differences n one of the plates of ›nsile strength. Plate being selected, double ›re cut out for test from cally opposite portions ıte, both with and across the direction of rolling, and numbered 10. One of each pair of pieces was shaped as usual, and the s rimmed out to the groove form.* G and C denote with and e grain respectively, and symmetrically opposite pieces are ›gether in the table, the better to indicate variation of quality.

Fig. 20.

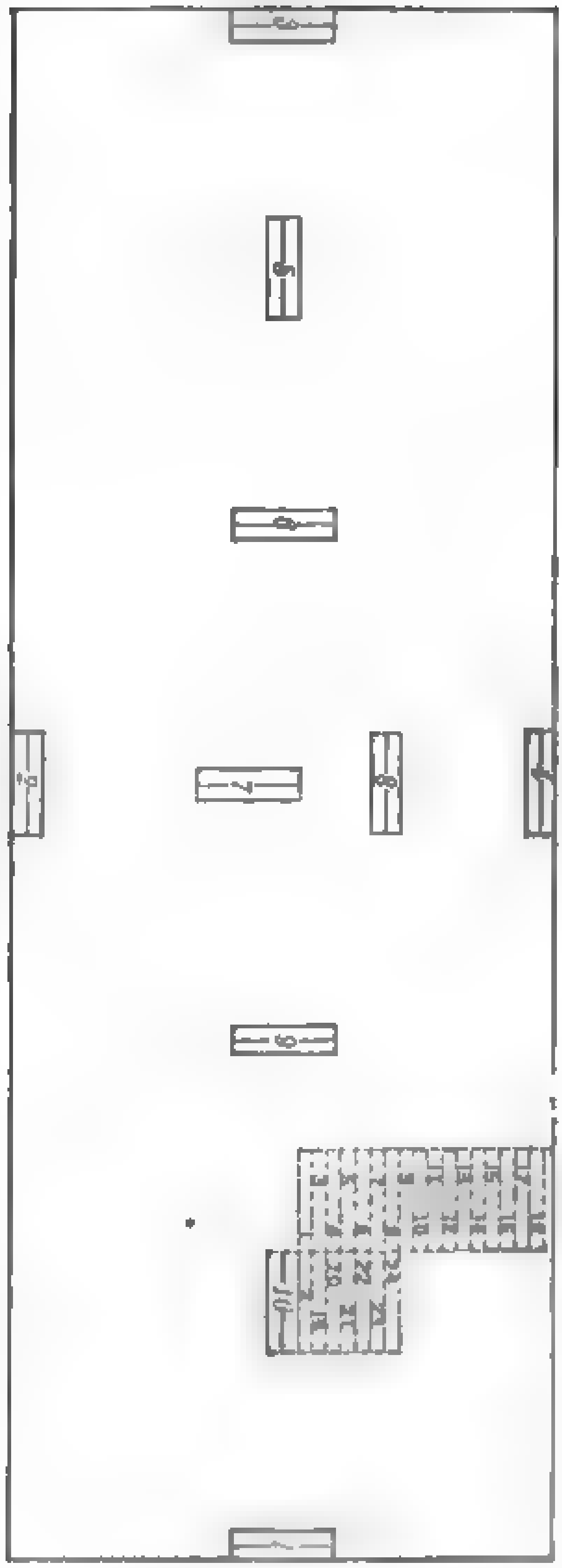


PLATE 678—W.

*he section numbered 10, the pieces were subsequently taken for the tests on ›e of length of test piece, and are shown dotted, numbered 1 to 24.

The average of the five tests with the grain is 54,521 pounds tensile strength, and 28.76 per cent. elongation, as compared with 53,050 pounds and 29 per cent. of the two pieces annealed with the plates. The maximum difference of tensile strength with the grain is 5,200 pounds, between pieces G 2 and G 4, and the lowest value 52,100 pounds. The average tensile strength across the grain is 55,530 pounds, or 1,000 pounds in excess of that with the grain, and with slightly less variation. The results in the groove form show differences in about the same proportion, though not for the same portions of the plate. Thus the lowest tensile strength in the groove form is in piece C 1, side by side with that showing the highest value in the 8-inch length.

TABLE XXXVI.—*Tests for homogeneity of one of the annealed plates intended for Chicago boilers.*

Marks.	8-inch length.						Groove form.				
	Original width.	Original thickness.	Original area.	Ultimate tensile strength.	Final elongation.	Final area.	Original width.	Original thickness.	Original area.	Ultimate tensile strength.	Final elongation.*
C 1	1.003	.682	.6736	57,300	29.1	40.8	.640	.675	.432	59,500	27.2
C 3	1.123	.668	.7501	52,790	31.2	43.1	.609	.668	.401	60,200	23.0
G 5	1.095	.660	.7227	54,760	30.3	41.0	.609	.680	.414	65,450	29.0
G 10	1.000	.668	.6680	55,528	30.0	44.2	.646	.668	.420	62,000	30.0
C 6	1.312	.664	.6720	53,950	27.5	46.9	.604	.680	.411	65,000	29.5
C 9	1.071	.675	.7220	54,910	29.0	51.0	.630	.670	.422	63,000	26.2
G 2	.960	.640	.6242	57,300	26.0	43.6	.664	.630	.418	60,200	32.0
G 4	1.035	.630	.6520	52,100	26.5	36.0	.650	.638	.414	64,000	27.5
C 7	1.055	.660	.6963	57,300	27.5	51.0	.650	.663	.416	64,000	25.5
G 8	1.015	.665	.6750	52,880	30.1	36.2	.622	.668	.415	64,000	31.0

* On a 1-inch length disposed equally about the plane of least area.

In a special report on the subject of annealing as carried out at the mills, the inspector at the Norway Steel and Iron Works shows conclusively that the effect of annealing is frequently the reverse of what is to be expected. Curves A, B, C, Plate XIX., are strain diagrams, each plotted from the mean of four test pieces for unannealed boiler plate from three heats. The results are analyzed in Table XXXVII., showing excellent quality, while the curves give evidence of comparative homogeneity of the metal. From the middle of a plate of each of heats 274, 275, and 276, 8 test pieces were taken, four of which were subjected to the usual process of annealing by placing them in the annealing furnace with plates being annealed, and afterwards on the bed floor of the foundry to cool, observing the same course of treatment as that to which boiler plates are ordinarily submitted. Curves D, E, F, Plate XX., are the strain diagrams for the unannealed material, each being plotted from the mean of four pieces. Curves D′, E′, F′, are the strain diagrams for the corresponding annealed pieces. The results, as arranged for comparison in Table XXXVII., show very unexpected changes. The tensile strength and elastic limit have been increased, the latter in a greater ratio, so that the elastic ratio is increased. The stretch is much diminished, the final area increased, and the uniform elongation along the length is probably much less. The work capacity, as measured by the strain curve, is very much diminished, so that the effect has not been one of simple hardening, but the intrinsic quality has been seriously lowered.

The inspector reports that of twenty-five other heats tested before and after annealing, nine-tenths showed an average of 5 per cent. increase in tensile strength with a decrease in elongation of 4 per cent. in 8 inches, and recommends that boiler plate be not so annealed.

TABLE XXXVII.—*Analysis of tests with strain diagrams accompanying Lieut. F. J. Drake's special report on annealing.*

Heat.	Condition	Strain diagram	Carbon	Manganese.	Phosphorus.	Elastic limit per square inch.	Ultimate tensile strength per square inch	Elastic ratio.	Stress at rupture per square inch of original area.	Final elongation.	Final area.	Area of strain diagram	Work required to break a bar of 1 sq. inch sectional area and 8 inches long.	Ratio: Area str. diag. / Ult. T. S. × Elong'n.
			P. ct.	*P. ct.*	*P. ct.*	*Lbs.*	*Lbs.*	*P. ct.*	*Lbs.*	*P. ct.*	*P. ct.*	*Lbs. p. c.*	*Ft. lbs.*	*P. ct.*
[illegible]	Unannealed	A	19	37	.059	32,200	60,000	53.67	45,830	28.30	43.0	1,481,033	9,873	87.23
410	..do	B	13	30	.060	34,000	61,800	55.02	46,250	27.70	41.0	1,508,935	10,050	86.15
607	..do	C	.12	43	.060	36,500	60,900	59.93	47,500	28.00	41.0	1,543,290	10,289	90.50
274	do	D	.14	40	.057	30,600	60,060	50.95	47,900	30.25	44.0	1,618,440	10,756	89.09
	Annealed	D'	...	...	...	34,100	62,970	54.15	53,800	25.75	50.0	1,452,450	9,682	89.59
275	Unannealed	E	.15	.31	.056	30,200	60,300	50.08	46,800	29.25	43.7	1,572,900	10,486	89.17
	Annealed	E'	...	...	...	36,700	64,000	57.34	54,000	22.75	50.0	1,297,050	8,680	88.33
276	Unannealed	F	.15	30	.060	35,000	61,000	57.38	50,800	28.00	44.2	1,583,300	10,555	92.70
	Annealed	F'	...	...	...	39,200	62,120	63.11	51,900	23.00	48.0	1,277,850	8,519	89.44
282	Unannealed	G	18	.61	.048	33,000	63,800	51.72	51,000	27.50	60.0	1,495,131	9,967	85.22
	Annealed	G'	...	...	...	31,120	60,800	51.18	47,800	29.75	46.0	1,560,450	10,403	86.77
366	Unannealed	H	.21	.45	.050	35,000	64,320	54.42	52,000	20.60	48.0	1,488,430	9,923	86.80
	Annealed	H'	...	...	...	32,300	61,000	52.95	48,900	28.30	47.0	1,510,200	10,128	88.01
455	Unannealed	I	26	.40	.056	35,500	67,900	52.28	57,000	25.00	43.0	1,472,630	9,817	86.76
	Annealed	I'	...	...	...	32,800	62,100	52.82	51,100	27.00	41.0	1,474,050	9,827	87.93

That these effects are due essentially to the method of annealing as there practiced appears from the following experiments: A sheet-iron cubic box was made, 2 feet on the side, with hanging door in one face and top perforated with half-inch drilled holes, to allow the escape of gases. From a plate of each of heats 282, 366, and 455, which were comparatively high in carbon and manganese, were cut two sets of triplicate test pieces having contiguous sides. One set of three pieces from each plate was heated in a small furnace to a very light cherry red and placed in the annealing box on a bed composed of equal parts of pulverized charcoal and lime and allowed to cool. The results arranged for comparison in Table XXXVII. are as ordinarily to be expected, and are very comparable to those of Table XXXIV. for the Chester and Black Diamond metals. The ultimate strength and elastic limit are diminished in about the same ratios, from 6 to 7 per cent., so that the elastic ratio is but slightly diminished;* the final elongation is increased 2.08 per cent. in 8 inches, while the final area is less by 2½ per cent. of original area, so that the uniform elongation along the length is probably somewhat greater. The work capacity has been increased, showing improvement in intrinsic quality. Curves G, H, I, Plate XXI., for the unannealed, and G', H', I', for the annealed material, illustrate the changed behavior under stress.

The conclusion arrived at from a consideration of the results of annealing plates which have not been punched or otherwise worked so as to necessitate the removal of purely local strains is that the effect is as apt to be deleterious as beneficial, as the process is ordinarily carried out. Good metal shows little improvement in any case; and while inferior metal may be doctored up to show somewhat better test, the improve-

* A somewhat greater decrease in elastic ratio is to be expected.

ment in intrinsic quality is uncertain; but the fact that, as commonly done, annealing *may* continually and with reasonable certainty lower the working quality, and sometimes excessively so, should prevent any general resort to the practice for boiler- or other plate at the mills. It should also be remembered that each time a plate is heated and cooled without work upon it, it becomes more liable to damage from the next heat. Thus parts of flanged boiler plates may have been four times so heated before being worked in, if the plate was annealed before delivery.

Upon examining the different causes of the effects observed at the Norway and Chester works, the necessity of certain further precautions will appear. In the first place, the fuel should be comparatively free from ordinary impurities, and the flame should be kept neutral. The results will undoubtedly always be better if the furnace is so designed that the products of combustion are kept as much as possible out of contact with the material. While the heating up should be rather slow, the metal must not be soaked, and indeed should remain in the furnace the shortest time required to effect the desired results. Further, the temperature ordinarily applied is too high, and especially apt to be so locally. It need not be very much above the temperature of finishing at the rolls, and should never be above a medium cherry. It cannot be too carefully borne in mind that the temperature at which the original physical structure is destroyed and replaced by a coarser and weaker structure is considerably below bright yellow, and the metal should never be heated so high in annealing.

QUENCHING TESTS OF PIECES FROM DIFFERENT PARTS OF THE SAME INGOT AND OF SIMILAR PIECES DIFFERENTLY HEATED.

In consequence of the difficulty with the quenching test at the Norway works, in the early part of the inspection, certain tests were made by the inspector there as to the differences caused by taking the specimens from different parts of the plate with reference to original position of the ingot, and as to the effects of different methods of heating the pieces for test.

Pieces representing the upper and middle and lower end of the same ingots were taken for six heats and submitted to the quenching test with the following results. The pieces were all 2 inches wide and 10 or 12 inches long:

Quenching test.

[From upper end of ingot.]

No. of heat.	Thickness.	Behavior under test.
1	.562	Cracked nine-tenths of width on outer face, sides parallel.
2	.563	Cracked all across, sides parallel.
3	.563	Cracked one-third of width on outer face, ends touching.
4	.562	Broke suddenly at 35° opening.
5	.500	Cracked one-half inch on outer face at 90° opening.
6	.563	Satisfactory.

[From middle of ingot.]

No. of heat.	Thickness.	Behavior under test.
1	.495	Commenced to crack at 50° opening.
2	.452	Satisfactory.
3	.516	Commenced to crack when requirement was reached.
4	.521	Cracked one half inch on outer face, ends touching.
5	.515	Satisfactory.
6	.510	Broke at 60° opening.

Quenching test—Continued.

[From lower end of same ingots.]

No. of heat.	Thickness.	Behavior under test.
1	.497	Commenced to crack on both edges, ends touching.
2	.490	Satisfactory
3	500	Do.
4	516	Do.
5	520	Do.
6	516	Cracked one-third of outer face, ends touching.

The difference in behavior due to position in the ingot is very marked, the upper ends giving very unsatisfactory results, while all the pieces from the lower end passed the test, except, perhaps, No. 6 heat.

The average tensile tests for the middle and lower thirds of the ingot were as follows:

No. of heat.	Ultimate strength.	Final elongation
	Pounds	*Per cent.*
1	61, 259	26. 12
2	61, 667	27 12
3	58, 609	26. 50
4	58, 277	26. 00
5	60, 067	26. 00
6	63, 150	19. 00

Many plates being subsequently rejected on this test, additional experiments were made, including effect of different methods of heating. Pieces were taken from portions of plates representing what were originally the top, middle, and bottom of ingots from five heats of good quality—the tensile tests for four of these heats will be found in the table for Norway steel—and bent cold as finished, and after quenching from a cherry red, heated in a smith's fire with blast and in a still charcoal fire. Corresponding pieces were also cut from the slabs before rolling into plates (see p. 411) and submitted to quenching test with invariably satisfactory results.

Cold-bending tests.

[From upper end of ingots.]

No. of heat.	Mark.	Behavior under test.
1974	17 u 2	Cracked for [illegible] inch on outer face, ends touching; granular fracture
1993	19 u 2	Satisfactory
1995	20 u 2	Do.
2009	21 u 2	Do
2013	22 u 2	Cracked for [illegible] inch on outer face, ends touching.

[From lower end of same ingots.]

No. of heat.	Mark.	Behavior under test.
1974	17 ų 2	Clifts in three places ends touching
1993	19 ų 2	Satisfactory.
1995	20 ų 2	Do.
2009	21 ų 2	Do.
2013	22 ų 2	Cracked for 1 inch on outer face, ends touching.

[From middle of same ingots.]

No. of heat.	Mark.	Behavior under test.
1974	17 ū 2	Cracked for [illegible] inch on one edge, ends touching.
1993	19 ū 2	Do.
1995	20 ū 2	Satisfactory.
2009	21 ū 2	Do.
2013	22 ū 2	Do.

Quenching tests.—Pieces heated with blast.

[From upper end of same ingots.]

No. of heat.	Mark	Behavior under test.
1974	17 u 2	Cracked entire width on outer face, ends touching.
1993	19 u 2	Cracked 1 inch on outer face sides parallel.
1995	20 u 2	Satisfactory.
2009	21 u 2	Do.
2013	22 u 2	Commenced to crack, ends touching.

[From lower end of same ingots.]

No. of heat.	Mark	Behavior under test.
1974	17 ų 2	Broke at 130° opening; brittle.
1993	19 ų 2	Cracked entire width, sides parallel
1995	20 ų 2	Satisfactory.
2009	21 ų 2	Do.
2013	22 ų 2	Broke at 125° opening, hard.

[From middle of same ingots.]

No. of heat.	Mark	Behavior under test.
1974	17 ū 2	Cracked 1 inch on outer face, ends touching
1993	19 ū 2	Cracked [illegible] inch on outer face, ends touching.
1995	20 ū 2	Satisfactory.
2009	21 ū 2	Do.
2013	22 ū 2	Broke at 65° opening; hard.

Quenching tests.—Pieces heated in charcoal fire.

[From upper end of same ingots.]

No. of heat.	Mark.	Behavior under test.
1974	17 u 2	Cracked for 1 inch at 90°; hard.
1993	19 u 2	Cracked 2 inches, sides parallel; brittle.
1995	20 u 2	Satisfactory.
2009	21 u 2	Do.
2013	22 u 2	Commenced to crack at 95° opening

[From lower end of same ingots.]

No. of heat.	Mark.	Behavior under test.
1974	17 ų 2	Cracked 1½ inches at 80° opening; hard.
1993	19 ų 2	Broke at 40° opening; brittle.
1995	20 ų 2	Satisfactory
2009	21 ų 2	Do.
2013	22 ų 2	Broke at 35° opening; hard.

[From middle of same ingots.]

No. of heat.	Mark.	Behavior under test.
1974	17 ū 2	Cracked for 1 inch at 80° opening; hard.
1993	19 ū 2	Cracked for 1 inch at 90° opening; hard.
1995	20 ū 2	Satisfactory
2009	21 ū 2	Do.
2013	22 ū 2	Broke at 10° opening, brittle

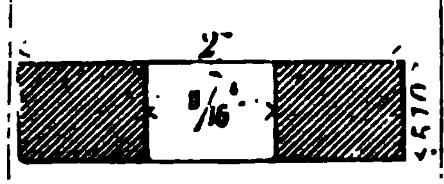
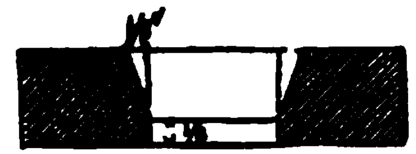
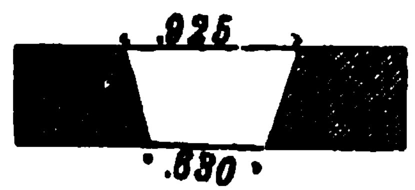
It appears that 2 heats, 1995 and 2009, gave invariably satisfactory esults from all parts of the ingot, and however heated. The cold tests lace the other three heats in the order of excellence 1993, 2013, 1974. The pieces being heated with blast and quenched, their order of excellence is 1993, 1974, 2013, with little difference between the last two. The pieces being heated in a still charcoal fire, their order of excellence is 1993, 2013, 1974. So that the order of excellence from each method of test is practically the same. But little difference appears due to difference in heating, the blast giving perhaps slightly better results than the charcoal fire.

As to position in the ingot, the cold-bending tests show no noticeable difference; in the quenching test with blast, the upper end gives the best results and the lower end the worst; in the quenching tests with charcoal fire, there is but little average difference. As the lower end of the ingot is generally expected to give the best results, the inspector concluded, on examining the heating furnace and method of heating, that the temperature at the back of the furnace was frequently too high and the flame too cutting. The attention of the heaters was called to this fact, and with increasing familiarity with the test, the difficulty soon disappeared.

EFFECTS OF PUNCHING.

A few tests were made at Chester on the effect of punching, with without countersinking, the ship plate of heat 486, that used for ecial tests with strain diagram, Plate XVI. The results, as n in Table XXXVIII., show a reduction of strength of $14\frac{1}{3}$ per , due to ordinary punching of an $\frac{11}{16}$ hole, only $4\frac{1}{3}$ per cent. if the be partially countersunk, as practiced at the ship-yard, and an ine of 2.12 per cent. for a $\frac{9}{16}$ hole countersunk through. The thickn each case was .51 inch and the width over all 2 inches. The ve size of punch and die, and consequent spread of hole, is not n. These results are as generally to be expected, the loss of gth being perhaps rather less than usual.

TABLE XXXVIII.—*Showing effect of punching, with and without countersinking. Chester steel plate.*

Heat.	Treatment.	Original dimensions of test piece.	Effective dimensions of test piece.	Effective sectional area.	Ultimate tensile strength.	Ductility in 8 inches.	Reduction of strength.	Cross-section through center of hole (half size).	Remarks.
						Per ct.	Per ct.		
486	Unpunched plate, four tests		1.00 x .507	.5070	64,200	25.15	......		Carbon, .12 per cent.; manganese. .37 per cent.; for heat.
486	Punched, $\frac{11}{16}$-inch hole	2.00 x .510	1.313 x .510	.6696	55,000	......	14.33		
486	Punched, $\frac{11}{16}$-inch hole, and countersunk as at ship-yard.	2.00 x .510	....	.6215	61,400	......	4.36		Commenced to crack at part of hole not counter-sunk, at 58,200 pounds per square inch.
486	Punched, $\frac{9}{16}$-inch hole, and countersunk through.	1.986 x .510	....	.6168	65,560	......	*2.12		Commenced to crack at small edge of hole, at 61,980 pounds per square inch.

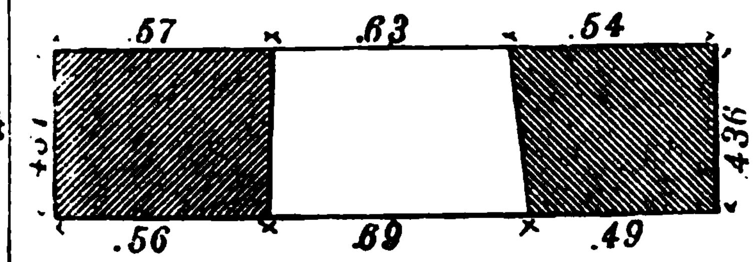
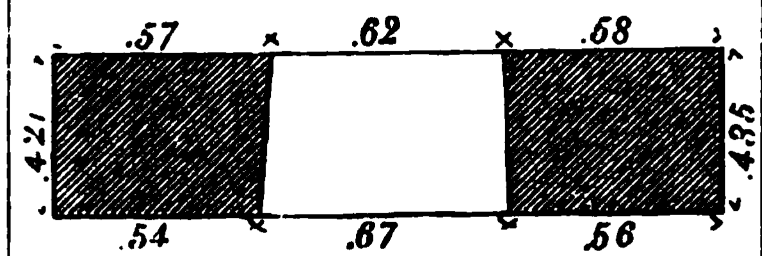
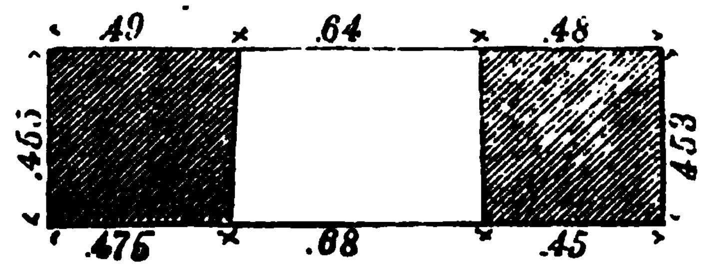
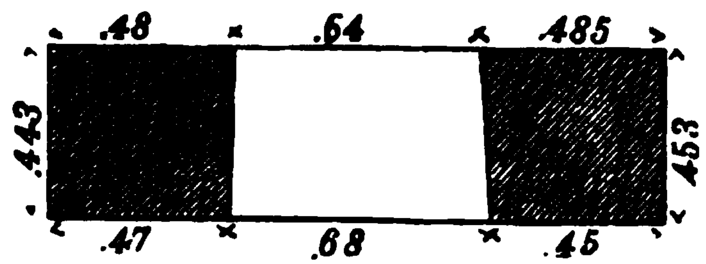
As is well known, the loss of strength from ordinary punching is due to the formation of a thin ring of highly strained metal forming the walls of the hole, of thickness depending on various circumstances, chief among which are the degree of hardness of the plate, its thickness, and the relative size of punch and die. The harder the steel, the thicker the plate, and the larger the die relatively to the punch,* the thicker is the overstrained ring of metal, and the greater the amount of subsequent riming or drilling necessary to remove it. M. Barba considered the removal of .04 inch of metal by cutting tool from a sheared edge or the walls of a punched hole sufficient to remove the bad effect in plates of ship or boiler quality not more than ½ inch thick. An extension of the investigation with steel of harder quality, by Mr. A. F. Hill, C. E.,† develops the following results. Strips of plates, ¼, ⅜, and ½ inch thick of open hearth steels of .30, .40, and .50 per cent. carbon were punched with ¾ inch holes, and tested with various amounts of riming. Enlargement of diameter by .04 inch effected the restoration only of the ¼ inch and ⅜ inch plates of .30 C., and of the ¼ inch plates of .40 C. Enlargement by .06 inch restored the ½ inch plate of .30 C., the ⅜ inch plate of .40 C., and the ¼ inch plate of .50 C. Enlargement by .08 inch restored the ½ inch plate of .40 C. and the ⅜ inch plate of .50 C., while the ½ inch .50 C. plate required an enlargement of fully .1 inch.

The effect of a hole produced by a cutting tool in a steel plate is to increase the ultimate strength of the net section, and while the effect of punching is always to overstrain the adjacent material, yet if the damage to the material is equal to or less than the gain due to difference of distribution of the resisting area owing to the presence of the hole, no apparent loss of strength will ensue. Again, plates of the same thickness, giving almost identical results on tensile test, frequently show very different results on punching. Some unknown element of chemical quality or physical structure causes the difference. Plates, therefore, do not always show an apparent loss of strength due to punching. Table XXXIX. gives the results of testing some $\frac{7}{16}$ inch flats of Cambria steel from two comparatively hard heats, punched with ⅝ inch holes not rimed. Careful measurements were made of the resisting areas, as shown on the sections, from which, also, it is seen that the average spread of the holes, owing to the clearance of the punch in the die, is about $\frac{1}{20}$ inch.

* While a relatively large die increases the thickness of the overstrained ring, and consequently the amount of riming necessary for its complete removal, the loss of strength due to such taper holes is less than with the proportions of punch and die commonly used.

† Vol. XI., Trans. Am. Inst. Mining Engineers.

TABLE XXXIX.—*Showing effect of punching Cambria steel flat.*

Heat.	Treatment.	Original dimensions of test piece.	Effective sectional area.	Apparent elastic limit.	Ultimate tensile strength.	Elastic ratio.	Ductility.	Reduction of strength.	Time of test.	Cross-section through center of hole, full size.	Remarks.
		In. *In.*	*Sq. in.*	*Lbs.*	*Lbs.*	*Per ct.*	*Per ct.*	*Per ct.*	*Min.*		
5565	Unpunched, 4 tests ...	1.240 × .433	.5366	44,030	66,469	66.24	*24.43	....	15		Carbon, .22 per cent.; manganese, .54 per cent.
5565	Punched, ⅝-inch hole ..	1.738 × .436	.4714	49,872	66,334	75.18	†5.5	.20	9¼		Fracture silky-plane. Somewhat laminated on one side. Opening of inner edge of hole 0.15 inch on each side.
5565	......do	1.773 × .428	.4816	53,011	64,118	82.68	†5.0	3.54	8		Fracture silky-plane. Opening of inner edge of hole 0.12 inch on one side and 0.105 inch on the other.
5565	Average punched		.4765	51,442	65,226	78.90	†5.25	1.87	8⅝		Rise of elastic atio, 12.66 per cent.
5567	Unpunched, 4 tests ...	1.243 × .449	.5580	41,576	65,475	63.50	*25.25	....	15¼		Carbon, .22 per cent.; manganese, .50 per cent.
5567	Punched, ⅝-inch hole ..	1.607 × .454	.4299	49,314	65,270	75.56	†4.63	.34	8		Fracture silky-plane. Opening of inner edge of hole 0.11 inch on each side.
5567	......do	1.602 × .448	.4220	48,104	65,640	73.29	†5.5	.27	9⅛		Fracture silky-plane on one side; irregular on the other. Opening of inner edge of hole 0.15 inch on one side and 0.11 inch on the other.
5567	Average punched	•..........	.4260	48,709	65,455	74.42	†5.07	nil	8⅝		Rise of elastic ratio, 10.92 per cent.
	Average, both heats punched.	....	....	....	....	....	....	.95	......	....	Rise of elastic ratio, 11.79 per cent.

Stresses were applied as usual in this inspection. The hole in each case commenced to elongate under a stress about the elastic limit of the unpunched metal, although the beam gave no indication of disproportionate extension until a considerably higher stress was applied; but the elevation of apparent elastic limit is believed to depend somewhat on the r dity with which stress is applied, being less with more rapid ion. The average rise of apparent elastic ratio is seen to be ly 12 per cent., an increase of nearly one-fifth. The walls of the nced to crack at a stress somewhat below the maximum, and occurred slowly and by visible shear with silky plane surfaces. difference of extension of the metal of the walls of the hole and at very noticeable, as seen in the column of remarks, making rei nt of reduced area of very uncertain value. The exten- punched pieces is given for 4 inches, but is really confined to immediately adjacent to the holes.

The average loss of tensile strength for one heat is *nil*, and for the other only 1.87 per cent., being then all in one piece. The average loss for both heats is only .95 per cent., or about 650 pounds.

A comparison of these results with those in Table XXXVIII. shows that while these flats were slightly thinner, they were also of slightly harder quality, but had received very much more mechanical work in the rolls. The proportion of net to original section is rather less in the Cambria pieces, giving the metal a slight advantage. But speaking broadly, this steel shows no reduction of strength due to punching, and its chief peculiarity is the very large amount of mechanical work which it has received, rendering a connection between the two qualities highly probable.

Few subjects stand more in need of exhaustive treatment than this of the effect of punching, and it may even fall within the province of the steel manufacturer, favorably situated for such work, to supply the solution as to the proper manufacture of metal to suffer the minimum of injury under ordinary conditions.

NEW SECTIONS.

In connection with the manufacture of material, certain new sections of deck beams and T rolled in steel are worthy of attention. Of the beam sections in general use in this country for iron, the large majority are deficient in width of flange, so much so that there is frequently not room enough to stow the rivets unless the very greatest care is exercised in punching and fitting. This small width of flange, together with the very round form of the bulb generally used in connection with it, makes the section deficient in lateral stiffness, one of the main causes of ultimate rupture; and this is also sometimes further aggravated by ex e thinness of web or stem, frequently such indeed that the beam be straightened or cambered without fluting, very much diminish its initial stiffness.

in, the design of these sections has been based largely on the con- ti that the ultimate resistance of wrought iron to compression bly less than to tension, the area of the flange being corre- ingly increased over that of the bulb. But it would appear that the ior of the metal under these strains within the elastic limit u trol the design, as actual rupture of the section in the ship is to contemplated, being in all cases preceded by too great de- ion, if the quality of the metal be good. Also, it is a significant

fact, that under the conditions of practice the capacity of iron and ste to stand repeated applications of the same stress within the elast limit is greater for compression than for tension. Thus in rivete girders of wrought-iron, in which the flanges are proportioned so as be theoretically of equal strength, fracture nevertheless almost inva riably occurs on the tension side under repeated application of load.

For steel the elastic limit and behavior within it may be taken a practically the same for tension and compression, so that, from wha has been said about repeated applications of stress, steel beams shoul generally have a greater area of bulb than of flange. This is not, how ever, practicable in any but the deeper beams.

In order to intelligently arrange the sizes and weights of beams i any case, beyond thumb-rule or the ordinary good practice, it is neces sary to remember that, of whatever pattern, the rolls are alway designed for a given weight, for which also the parts of the section ar proportioned to what may appear to be the best advantage. If it b desired to make a heavier beam, the rolls are spread; if a lighter, the are screwed together. The distance apart of the rolls is generally con sidered to affect all parts of the section alike, within certain limits, o the increase of width of flange and bulb and of thickness of web wi be identical.* On account of the greater length of web, however, th difference of weight will chiefly arise from the change of thickness the web. Thus, if, for the weight to which the rolls are designed, th thickness of web is suitable for the transmission of stress from flan to bulb by its resistance to shearing and buckling, any increase weight will diminish the efficiency of the beam per pound weight, ina much as the efficiency of the metal added to the web to resist tran verse straining of the beam is only one-third of an equal addition the flanges. It accordingly happens that a beam of given depth a weight from one manufacturer may have considerably less absolu strength and stiffness than a lighter beam, of the same depth but different pattern, from another maker. Thus, unless the beams are be made according to special pattern, which will rarely be the case, t exact weight per foot should be decided with reference to the desi of the rolls. For instance, consider the 8-inch 27-pound beam (Tal XL.) used amidships on certain decks of the Atlanta, Boston, a Chicago, in comparison with the 24½-pound beam of the same patte used at the extremities of the same decks. The exact weight of t heavier beam in accordance with the actual section used for calculati is 27.3 pounds, that of the lighter 24.45 pounds, so that the heavi beam weighs 11.65 per cent. more than the lighter. The moments resistance are respectively 16.52 and 15.90, or the heavier beam is on 3.9 per cent. stronger or stiffer, since the moment of resistance is better measure of stiffness than of ultimate strength. The rolls we designed for 25 pounds, for which weight the parts are considered w proportioned, and it is seen that the increase of strength for increas weight is altogether disproportionate. The relative efficiency of t two sections may be seen from the last columns to be as .605 to .65, or t heavier beam is 6.9 per cent. less efficient than the lighter. Th efficiency as gauged by the moment of resistance per pound weight foot may be apparently much increased by rolling the section bel the designed weight, but only at the expense of diminished ultim

* The truth of this proposition will depend on the details of the roll passes, as flanges may not fill the grooves in the last few passes, in which case practically difference in width of flange will occur over a considerable range of weight.

ıgth of the section from lack of strength and stiffness of the web ı y strains. Where stiffness alone is to be considered, this gı rally be done with advantage, and indeed is contemplated in a reuuctions as above mentioned. But without inordinate expense, nufacturer cannot make rolls to suit each individual case, unless a r be large, and it frequently happens, as shown, that the lighter nay be practically as stiff and as strong as the heavier.

ı foregoing considerations have been based upon the qualities of ıs unsupported by plating. When so supported, the maxi- ıciency demands diminished flange area, larger fillets under ı ıge, thicker webs, and especially larger bulbs. The plating in virtually increases the flange area resisting compression, calling for ›nding increase on the tension side of the girder and in the con- a ıg web. The beams supporting protective deck-plating should be ıed with this in view, and such beams generally have an angle, or one ed, flange. Such beams, as well as those subjected to violent and vio ory strains and generally supported by plating—at least over p most severely strained—are usually comparatively deep, so ıue better to satisfy the average conditions the deeper beams l not have increased width and area of flange, but heavier webs ›ecially larger bulbs. Where the depth of beam is to be dimin- ırom considerations of space, it may well happen that under plat- › of the deeper rail patterns may be used to advantage, being at ı weight for weight, preferable to tees or double angles, while hav- sufficient flange area for connection to the plating.

As regards the pattern of steel beams, the flanges should not have more taper in thickness than is necessary for rolling, in order to increase the lateral stiffness. The metal of the bulb, on the other hand, is more efficient when concentrated, but by a flat pear-shaped bulb the virtual depth of the beam is increased, while connection with the pillars is more effective, and, as worked into carlings around mast-holes, &c., plating may be more readily secured by tap-rivets. Under the conditions of the metal in the web of a beam, it is probable that with steel of ordinary ship quality the thickness need be no greater than is common in well-designed iron beams. With steel of harder quality, the webs should be thicker; or it may be considered advisable in deep beams to increase the amount of reduction in the last pass (generally very small) and cut or stamp the rolls so as to leave vertical ribs in the web to increase the stiffness, where such projections will not interfere with the faying of the connecting pieces.

Plate XXII. shows the sections rolled under this inspection, illustrating some of the above remarks. Actual sections are shown except for the light 8-inch beam. Of the 7, 8, and 9 inch beams, the flanges are rolled for 5 inches, the bulbs are pear-shaped and perfectly flat on the under side, the webs terminate in deep fillets and are considered well proportioned for the weights for which the rolls were designed, viz. the 7-inch for 25 pounds, the 8-inch for 25 pounds, and the 9-inch for 28 pounds. The flanges have as little taper as was deemed safe in rolling, but this may be reduced with advantage. The 6-inch 16-pound beam was finished on rolls which had been used for iron. Considerably increased efficiency is apparent in the 18 pound 6-inch beam rolled especially for this order, but from trouble in the details of rolling the bulb-fillet on one side is misshapen. The size of the bulb of this beam may be increased with advantage.

Table XL. contains the chief properties of some of these sections, ac-

companied by those of iron beams of approximately the same weight as rolled at one of our most prominent mills. These are not given so much for comparison of efficiencies, because generally designed for much lighter weights, but to illustrate general features and clearly show the large differences which may arise between beams of the same weight of different patterns. The properties are as given in the manufacturer's hand-book. By the moment of resistance is meant the bending moment which will produce a stress of 1 pound per square inch on the extreme fiber.

TABLE XL.—*Properties of certain beam sections.*

Nominal size of beam.	Area of section.	Corresponding weight per foot	Thickness of web	Width of flange.	Width of bulb	Neutral axis above bottom of bulb.	Moment of inertia about neutral axis	Radius of gyration.	Moment of resistance.	Moment of resistance per pound weight per foot
	S. ins.	*Lbs.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*	*Ins.*
9 inches by 5 inches by 31 pounds[1]	8.97	30.41	583	5.06	2.12	4.93	99.10	3.34	20.20	.666
9 inches by 30 pounds[2]	9.00	*30.51	.625	3.97	1.97	4.60	91.90	3.20	20.00	.655
8 inches by 6 inches by 27 pounds[3]	8.03	27.30	.531	6.00	2.04	4.40	72.68	3.00	16.52	.605
8 inches by 27 pounds[4]	8.10	*27.46	.712	3.06	1.71	4.49	61.60	2.70	13.75	.501
8 inches by 5 inches by 24½ pounds[5]	7.21	24.45	.437	6.00	2.00	4.31	68.55	3.08	15.90	.650
8 inches by 24½ pounds[6]	7.39	*25.02	.614	3.96	1.61	4.49	57.30	2.79	12.75	.509
7 inches by 5 inches by 25 pounds[7]	7.12	24.14	.458	4.90	2.08	3.87	51.06	2.68	13.19	.546
7 inches by 23 pounds[8]	6.90	*23.40	.625	3.75	1.75	3.99	43.60	2.50	10.90	.463
6 inches by 3½ inches by 16 pounds[9]	4.82	16.34	.417	3.48	1.85	3.53	24.31	2.24	6.89	.422

* Weight if rolled in steel.
[1] Used for gun-deck beam, Chicago.
[2] Iron, as manufactured at Union Iron Mills.
[3] Berth and spar decks, amidships, Chicago; berth and main decks, amidships, Boston and Atlanta.
[4] Iron, as manufactured at Union Iron Mills.
[5] Berth and spar decks, for'd and aft, Chicago; berth and main decks, for'd and aft, Boston and Atlanta.
[6] Iron, as manufactured at Union Iron Mills.
[7] Main-deck beam, Dolphin.
[8] Iron, as manufactured at Union Iron Mills.
[9] Berth-deck beam, Dolphin.

Plate XXII. shows the section of the 4½″ by 3″ tee used for bulkhead stiffeners and in other places on the larger vessels. The primary object of such a section in ship construction at the present time being to serve as an edge strip across the joint of bulkhead plates while the stem acts as a stiffener, the flange is made broad and of parallel thickness slightly in excess of ordinary bulkhead plating, while the stem or tongue is only as deep as the deep flange of angles used for stiffening purposes. The stem of a tee should have the least possible taper consistent with good rolling so as to throw the metal as far out as possible.

The open and close tests for deck beams and tees are illustrated by broken lines. In the tee, the stem may also be laid flat on one side of the flange.

PROPOSED SECTIONS.

There seems no reason why in future construction advantage should not be taken of some sections of great efficiency and lightness which have for some time been used in Europe. The more important of these is the 6 inch Z (Plate XXIII.) extensively used in the main framing, where only one thickness of plating is worked, and around magazines,

PLATE XXIII.

I Bar
6"x 3½"x 3"x 15 lbs.
Proposed New Sections
in Steel.
Angle Bulb
5"x 2¾"x 11 lbs.

to tapping, arising from the large scale on which the manufacture is carried on and the precision and smoothness of working necessary in the face of active competition.*

But structural steel has also been occasionally subjected to chemical requirements. For "fire-box metal," or the parts of a boiler in contact with the flame, it has long been recognized that low phosphorus is highly desirable in steel as in iron. If the percentage of phosphorus be much above .05 per cent. in such material, internal strains appear to be produced under the ordinary conditions of working, causing rapid deterioration and sometimes sudden failures. Accordingly such material is generally purchased with explicit agreement or general understanding that this limit is observed.

Certain bridge engineers have of late undertaken to exact chemical requirements for bridge steel, and the specifications of the railroad bridge across the Ohio River at Henderson, Ky., extracts from which are given in Appendix, p. 577, *et seq.*, contain requirements for higher and lower limits of carbon for both tension and compression metal and the .10 per cent. limit for phosphorus, together with what are believed to be the most elaborate physical tests ever applied to structural material. Whatever opinion may be entertained as to the necessity of such requirements, or indeed of their propriety in the present state of our knowledge of the subject, they at least mark a tendency in the direction of chemical specifications, and the steel has been successfully made to them.

While the possibility of chemical specifications being relied upon for structural steel is very remote, yet, in originating requirements for material it becomes necessary, especially in connection with intended cost, to appreciate the margin allowed the manufacturer; and although, as we have seen, the physical qualities of steel are affected in many ways, some little understood, by treatment subsequent to tapping, yet, at any particular works, the methods and appliances in use, if not the best, cannot be altered without serious expenditure of time and money, so that for range of physical quality the manufacturer relies solely on the ingredients and proportions of the charge and subsequent treatment in the furnace. With this as the preliminary consideration, an analysis of the results of tensile tests on a chemical basis was undertaken. While, in order to avoid the region of debate, the Board confines itself to the most general discussion of the results, yet it will be readily understood that for even a general analysis of, and useful deduction from, a large number of tests as contained in lengthy tables, an amount of arithmetical labor is necessary such as to deter any but the most persistent investigator from the attempt, so that a summary upon any acceptable basis may well form a valuable addition to the itemized results.

But before proceeding to such a consideration of the results, it becomes necessary to examine the ground work in stating and considering the methods of chemical analysis commonly used in American steel works. While the differences arising are rarely comparable to those obtained from physical tests under different systems, they are yet considerable, and offer almost as much field for discussion, both as to the

* In general for this class of steel the number of points, or hundredths of 1 per cent., of carbon may be fairly used as the gauge of mere hardness or softness, with the restriction that the phosphorus, the other chief hardening agent, is within the Bessemer limit of 0.10 per cent. For such steel also the percentage of phosphorus is taken as an inverse measure of intrinsic quality, so much so that, as this element is not removed in the ordinary Bessemer process, pig-iron containing sufficient silicon for the blow, and not more than the above-mentioned amount of phosphorus, is termed Bessemer pig, and f rms a separate class in the trade.

most suitable methods and the results of any one method in the hands of different individuals. Considerations of expense largely control the choice of method and, to a certain extent, the manipulation under the method chosen.

METHODS OF CHEMICAL ANALYSIS USED IN AMERICAN STEEL WORKS.

A *complete* analysis commonly consists of determinations of combined carbon, phosphorus, manganese, sulphur, and silicon, although sometimes extended to include graphitic or dissolved carbon, copper, nickel, and cobalt. The amount of chemical analysis made on each heat or blow of steel depends very much upon the experience of the melters, the variety of product, the degree of knowledge of the ingredients of the charge, and finally upon individual practice. But few of the above determinations are ever made except in particular cases, and much steel is not sampled for the chemist at all. A general knowledge of the ores, with a few special analyses, suffices, as a rule, for an estimate of such elements as copper, nickel, and cobalt, the variation of which is of no consequence if the maximum probable quantity present be not too great. Careful account is generally taken of the pig used directly or to be puddled, with respect to the elements commonly included in a c plete analysis, and the scrap used, if its history is not known, is npled as completely as deemed necessary. The ferro-manganese and egeleisen are bought on analysis for certain elements carefully de- mined and the average amount of the other principal elements is taken account of. Thus much chemical work is generally done to obtain a more or less accurate knowledge of the composition of the charge.

The open-hearth process effects practically the complete* elimination of manganese and silicon and the reduction of carbon to the desired extent; the necessary amount of manganese is subsequently added with a small increase of carbon and silicon. The other elements are generally not cted. The product is therefore tested almost invariably for carbon frequently for manganese. When boiler metal is aimed at, the e t amount of phosphorus may also be determined.

The Bessemer process generally effects the complete* removal of silicon and manganese and, in this country, of carbon, the two latter elements being then added to the desired extent. A certain amount of silicon being necessary for the "blow," this element is generally determined for the pig used, though much may be told from its fracture. A specially large number of silicon determinations are made when the "direct" process is worked, the metal being taken fluid from the blast furnace to the converter, no mixing being possible. The same determinations are generally made for Bessemer as for open-hearth steels.

In the basic Bessemer, or Thomas-Gilchrist, process, phosphorus must be added to the number of elements removed, and becomes the subject of careful study in charge and product.

COMBINED CARBON.

Mr. J. Bludgett Britton's Modification of Eggertz's† method (*vid.* Jour. Franklin Institute, May, 1870), is in general use, almost every chemist

* By complete elimination or removal as here used is meant the reduction below certain very small quantities.

† Dr. Eggertz's original method is as follows: "Dissolve in the cold 1–10 grm. of steel in from 1¼ to 5 cubic centimeters of nitric acid (1.2 sp. gr.); place in water bath at 80° C.; cool, and pour off solution; pour a few drops of nitric acid on the residue in

introducing individual peculiarities of manipulation. It consists of a comparison of colors of solutions, in nitric acid of definite strength, of the steels analyzed with those of standard steels or with derived solutions.

A solution of coffee or caramel in weak alchohol—or better, a mixture of the two, as the mixture does not change color so quickly as the single solution—is made of such strength that its color corresponds exactly with that of a solution of 1 gram of standard steel (combined carbon accurately determined by special method), in 15 cubic centimeters of nitric acid (1.2 specific gravity). A second standard steel is taken with about .10 per cent. more carbon and 15 cubic centimeters of its darker solution is diluted with weak alcohol until its color corresponds with that of the lower carbon steel, the exact amount of the alcohol used being noted. The intervening standards, generally 2 points, or .02 per cent., apart, are then made by diluting 15 cubic centimeters of the solution corresponding to the higher carbon steel with proportionate amounts of alcohol. Similarly standard solutions for the next range of 10 points, or .10 per cent., of carbon may be obtained. The solutions, in test tubes of exactly the same diameter and hermetically sealed, are placed in the order of color in a tube rack with a space between each pair for the insertion for comparison of the nitric acid solution of the steel to be analyzed. The lowest color in a rack much used for soft steels is frequently given by a piece of selected colored glass in distilled water. A piece of tracing paper, ground glass, or a porcelain plate is attached to the back of the rack for the better definition of the colors. When not in use, the rack should be kept in a dark place and should be tested for change of color at least once a month.

The estimation of the carbon in a number of samples is conducted as follows:

One gram of each steel, finely divided (preferably by drill or other cutting tool), is added gradually to 10 cubic centimeters of nitric acid (1.2 specific gravity) in a tube, 1 to 1½ inches diameter, surrounded with cold water. When solution is almost complete the tubes are placed in a water bath containing water at 80° C. and heated for one hour, cooled rapidly in cold water, and filtered through a filter paper 9 centimeters in diameter, not previously moistened, into tubes of the same diameter as in the standard rack. When the solutions have reached a fixed temperature the carbon is determined by a comparison of shades.

Absolute uniformity of manipulation is necessary with this method, especially with the very soft steels, which give a very light solution.

The exact strength of the acid used, its purity, the exact amount of acid used, the size of the drillings, the heat at which solution takes place, the rapidity of solution, the length of time the tubes stand before being placed in the hot-water bath, the exact temperature of the bath, any variations of that temperature, the length of time in the bath, the amount of evaporation, the temperature of filtration, the length of time between filtration and comparison of colors, the temperature of comparison, the exact size and thickness of the tubes used, with any variation of each, the light in which comparison is made, all affect the apparent amount of combined carbon present.

When the doubtful representative value of the sample for chemical test as generally taken with respect to the pieces subjected to physical test is considered, especially in view of the recently discovered prevalence of hard centers or fluming of the impurities to the top and center

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the tube and heat carefully over a lamp until there is no further liberation of gas: cool and add to the former solution. The liquid is now diluted until its color corresponds exactly with the standard which is of such a strength that 1 c. c. represents .0001 grm. of carbon." This method is not so accurate as Mr. Britton's modification.

of the ingot, it is evident that averages of many tests are necessary for consistency of results for steel of any one manufacture, and accurate comparison of independent results for steel of different manufactures is very difficult if not impossible.

PHOSPHORUS.

To the chemist, as to the steel manufacturer and worker, this element has very treacherous qualities, and the greatest care is necessary for its accurate determination. Several methods are in use, of which the chief are, in the order of accuracy, the molybdate and magnesia method, with various modifications, the direct molybdate or yellow precipitate method, and the acetate or citric acid method. The first two are the most commonly used.

Molybdate and magnesia method.—Dissolve 3 to 5 grams of steel in nitric acid (1.2 specific gravity), using about 15 cubic centimeters per gram of steel. When solution is complete, add 5 cubic centimeters of hydrochloric acid, evaporate to dryness and heat on the hot plate or sand bath until all the acid is driven off. The hydrochloric acid prevents the formation of basic salts. Dissolve in concentrated hydrochloric acid, using only a small amount, boil for a few minutes, and evaporate quite low. Evaporate twice with 30 cubic centimeters of nitric acid, taking care not to render the iron oxide insoluble in nitric acid; dilute, and filter from silica. The filtrates and washings, which need not exceed 150 cubic centimeters, are neutralized completely with ammonia and a slight excess added. The precipitate is dissolved with concentrated nitric acid and the solution brought to a reddish yellow color; add ammonium molybdate solution in large excess (20 cubic centimeters per gram of steel), heat the beaker for fifteen to twenty minutes at 80° C., allow to stand at about 50° C. from an hour to an hour and a half, until the yellow precipitate has entirely settled to the bottom, and filter. Thoroughly wash the precipitate with an acid solution of ammonium nitrate—made of 325 cubic centimeters of nitric acid (1.2 specific gravity), 100 cubic centimeters ammonia (0.96 specific gravity), and 100 water—and dissolve with dilute ammonia on the filter; acidify with hydrochloric acid, and add ammonia to the very slightest perceptible excess. Heat the solution on the steam bath until all odor of ammonia is removed and a slight flocculent precipitate has separated; filter, add ammonia to the filtrate, and precipitate with magnesia mixture, stirring briskly for several minutes.

The flocculent precipitate (often spoken of by mistake as silica) sometimes contains a trace of phosphorus, which can be regained by dissolving in warm nitric acid, precipitating with molybdate solution, and, after fifteen or twenty minutes, filtering off the precipitate, which is then dissolved in ammonia and added to the main solution.

If the final precipitation is to take place rapidly, the solution should not exceed 50 cubic centimeters. As soon as the liquid above the precipitate is perfectly clear, it may be filtered. In this case, as with the yellow precipitate, clear liquid indicates complete precipitation. Now filter through a 7-centimeter paper, and wash with a solution of 1 part alcohol, 1 part ammonia (0.96 specific gravity), and 2 parts water, by bulk; transfer to a crucible, wet, and turn on the full heat of a Bunsen burner until the paper begins to char, when the flame is turned low and the carbon burned off at a dull red heat.

Weigh the precipitate as pyrophosphate of magnesia as soon as cold. (See Vol. X., Trans. Am. Inst. Mining Engrs., p. 330.)

Another way of working the molybdate and magnesia method, used in several steel works, is as follows:

Dissolve the steel in nitric acid; evaporate to dryness and heat in an air bath at 120° C. for several hours; dissolve in hydrochloric acid; filter; expel hydrochloric with nitric acid; precipitate in small bulk, made nearly neutral by ammonia, with ammonium molybdate solution; filter, and wash with acid ammonium nitrate, dissolve with ammonia; precipitate with magnesia mixture; filter and wash with ammonia-alcohol or dilute ammonia; ignite and weigh as pyrophosphate. (*Ibid.*, p. 323.)

Either of these two methods give accurate results if ordinary care is used in the manipulation. The points to be watched are to have the solution free from hydrochloric acid or chlorides and to have only enough free nitric acid present to keep the iron oxide in solution when precipitating with ammonium molybdate solution. The presence of

a large excess of ammonium nitrate hastens the complete separation of the yellow precipitate, and, to a certain extent, neutralizes the deleterious effect of chlorides. The first method requires from twelve to thirty hours; the second, forty-eight to seventy-two, with no greater accuracy.

A modification of the molybdate and magnesia method used at, at least, one steel works is as follows:

Dissolve in nitric acid; evaporate to dryness and render silica insoluble on sand bath; take up in hydrochloric acid; evaporate low and add ammonia in excess. Dissolve precipitate formed in concentrated nitric acid and filter from silica; precipitate with molybdate solution; filter, and wash with dilute molybdate solution; dissolve with ammonia; precipitate with magnesia mixture, and let stand two to three hours; filter and redissolve precipitate with hydrochloric acid (1 in 2); add citric acid; neutralize with strong ammonia, adding one-third volume in excess, and let stand four hours or more; filter, and wash with dilute ammonia; ignite, and weigh. The results are too low and entirely untrustworthy. (See Vol. X., Trans. Am. Inst. Mining Engrs., p. 203.)

Yellow precipitate method.—The Eggertz direct, commonly called the yellow precipitate, method is used in many steel works from the rapidity with which it can be worked. The results are not generally accurate unless all the conditions of manipulation are carefully systematized. The method is as follows:

Dissolve 1 gram of steel in nitric acid, evaporate to dryness, and heat on a hot plate or sand bath until free from acid; take up in concentrated hydrochloric acid, and evaporate low; add 5 cubic centimeters of nitric acid, dilute slightly, and filter from silica; evaporate solution to 20 cubic centimeters, add 20 cubic centimeters of molybdate solution, and stir. Heat to about 40° C. until precipitation is complete, and filter through weighed or counterbalanced filter papers; wash precipitate with water containing 1 per cent. of nitric acid until a drop of the filtrate leaves only a slight ring on being evaporated to dryness on a watch glass. Dry at 110° C. until a slight stain appears on the filter paper. One and sixty-three hundredths per cent. of the weight of the precipitate is calculated as phosphorus. (Chemical News, Vol. VIII., p. 254.)

The Brushing method (Trans. Am. Inst. Mining Engrs., Vol. X., p. 167) is the same as the above except that a larger quantity of steel is used and as much as possible of the dried precipitate is brushed from the filter paper and weighed on a watch glass, the remainder adhering to the filter paper being considered unworthy of attention. This method is in use, though no chemist taking pride in his work would introduce mechanical defects into chemical methods.

The yellow precipitate method as described gives low results on account of the incomplete precipitation of phosphorus in presence of hydrochloric acid, the error increasing with the amount of phosphorus. If the phosphorus is low—below .07 per cent.—fairly accurate results may be obtained by twice washing the precipitate with nitric acid to remove the hydrochloric, keeping the amount of free nitric acid down to about 5 cubic centimeters. When the phosphorus is from .07 to .12 per cent., the analyses will then show too much phosphorus, the error being as great as .01 per cent. at the higher figure; and if .15 per cent. of phosphorus be present the error becomes .02 per cent. If, however, the amount of free nitric acid present be increased to 10 cubic centimeters, the analyses will show too low. It would thus appear that when the approximate amount of phosphorus is known, reasonably accurate results may be obtained by varying the manipulation. But the general question is in dispute.

The causes of variation in results by this method are the amount of nitric acid present, the amount of iron per cubic centimeter, the temperature of precipitation, the strength of the molybdate solution, the amount of hydrochloric acid, and the impossibility of freeing the pre-

ipitate from adhering impurities by washing with water containing 1 er cent. of nitric acid.

In c ing the molybdate and magnesia and the yellow precipitate us, the most striking difference is that, whereas in the molybdate nu magnesia method 27.93 per cent. of the magnesium pyrophosphate eighed is phosphorus, in the yellow precipitate or direct method only 63 per cent. of the ammonium-molybdenum-phosphate is phosphorus, apparent risk of error being therefore as 17 to 1 against the lybdate and magnesia method. But this is not the case, since the osition of magnesium-pyrophosphate is constant, while that of le ammonium-molybdenum-phosphate is variable, being affected by the nount of free nitric acid present as mentioned.

Citric acid or basic acetate method.—Though in use at few steel orks, this method is employed by many commercial chemists. It is ntially as follows:

Dissolve 5 grams of steel in concentrated nitric acid to which a few drops of drochloric acid have been added; replace nitric completely with hydrochloric acid id filter from silica; dilute filtrate to 600 cubic centimeters, and add ammonia until a ght cloud forms; add 7 to 10 cubic centimeters concentrated ammonium sulphite, id boil until sulphurous acid is removed; cool by placing containing beaker water, and add ammonia in just excess enough to produce a greenish precipitate. ld 40 cubic centimeters of acetic acid, and boil about 20 minutes; if the precipitate, ter boiling 5 minutes, is very small or light-colored, add a few drops of ferric chloride id boil again. Filter the precipitate as hot as possible, and wash slightly with hot ater. Dissolve in as little hot hydrochloric acid as possible, wash filter with a lution of 2 or 3 grams of citric acid in a little water, and complete washing with t water. Evaporate filtrate and washings to 30 cubic centimeters, add excess of nmonia, cool, and add 6 to 8 cubic centimeters of magnesia mixture, stirring until e precipitate appears. Let stand in a cool place for 16 or 18 hours; filter, and ash slightly with dilute ammonia; dissolve with dilute hydrochloric acid on filter, ash with solution of ½ to 1 gram of citric acid, and complete washing with hot ater; cool, add ammonia, and cool again; add a few drops of magnesia mixture, irring until the precipitate appears. Let stand 6 or 8 hours; filter, and wash with lute ammonia; ignite and weigh as magnesium pyrophosphate.

The majority of chemists using this method obtain low results. The ises of error seem to be the incomplete precipitation of phosphorus s basic phosphate of iron and the well-known solubility of ammonium-gnesium-phosphate in citrate of ammonia.

MANGANESE.

The following method proposed by Mr. S. A. Ford (Trans. Am. Inst. lining Engrs., Vol. IX., p. 397) is the most convenient and accurate r the determination of this element, and is much used:

Dissolve 1 gram of steel in concentrated nitric acid (1.4 specific gravity), bring to violent boil, and throw in chlorate of potash until the yellow fumes cease; add a ttle more chlorate of potash, and boil a minute or two, filter through asbestos, and ash with hot concentrated nitric acid until free from iron. Dissolve the binoxide manganese in hydrochloric acid, filter from asbestos, and wash with hot water; arly neutralize with ammonia; add a very small quantity of acetate of soda and il; filter, and wash lightly with hot water; redissolve the small quantity of oxide iron in hydrochloric acid, again nearly neutralize with ammonia, and add a small ystal of acetate of soda; boil and filter. Unite the two filtrates, add an excess of sphate of soda, then an excess of ammonia, and boil. When the precipitate is letely down and has assumed the silky appearance of ammonium-manganous te, filter, wash with hot water, ignite, and weigh as manganous pyrophos-iate.

It should be remarked that asbestos often contains magnesia and lime hich are liable to contaminate the final precipitate.

A very convenient method for the determination of manganese be-ved to have been devised by Mr. Setterwald, of the Vulcan Steel

Works, Saint Louis, but published by Mr. Fred. H. Williams (Trans. Am. Inst. Mining Engrs., Vol. X., p. 100) is given as follows:

Prepare two standard solutions, the first a permanganate solution of such strength that 1 cubic centimeter is equivalent to 1 milligram of iron, and the second an oxalic acid solution such that 1 cubic centimeter is equivalent to 3 cubic centimeters of the permanganate solution.

Dissolve one or two grams of steel in concentrated nitric acid, and add chlorate of potash until the binoxide of manganese is completely precipitated; filter through asbestos, wash with hot water, and place precipitate and asbestos in a beaker: add a measured quantity of the standard oxalic acid solution slightly in excess of what the binoxide is capable of oxidizing; dilute to 60 cubic centimeters, add 3 or 4 cubic centimeters of concentrated sulphuric acid, heat to 70° or 80° C., and titrate with permanganate solution. Calculate the weight of iron equivalent to the oxalic acid oxidized by the binoxide, and the amount of manganese may be obtained from the proportion 112 : 55 : : weight of iron oxidized : x = weight of manganese. The method gives slightly low results, and may be improved by substituting a standard solution of ferrous sulphate for that of oxalic acid.

The Acetate Methods.—The two allied acetate methods are in very extensive use, viz., the ammonia and bromine, and the fixed alkali and bromine.

The ammonia and bromine method is as follows:

Dissolve in aqua regia or nitric acid, evaporate to dryness, and render silica insoluble; take up in hydrochloric acid, and filter; dilute to 1 liter, and neutralize with ammonia and carbonate of ammonia; add acetate of ammonia in excess, boil until the iron separates, and filter; redissolve in hydrochloric acid and repeat the separation as before. Cool the combined filtrates, and add bromine and strong ammonia. When the manganese oxide has separated, boil, filter, wash, dry, and weigh as Mn_3O_4.

In the fixed alkali and bromine method, carbonate of soda replaces ammonia and carbonate of ammonia, and acetate of soda is used instead of acetate of ammonia; no strong base is added after addition of bromine.

Almost every chemist has his own modifications of these methods, the results obtained varying from very low, through accuracy, to very high, according to individual modifications and the skill of the manipulator. (See Trans. Am. Inst. Mining Engrs., Vol. X., pages 105–9, 173, 191, and 194.)

Volhard's manganese method is used to a limited extent. (Trans. Am. Inst, Mining Engs., Vol. X., page 203.) It is as follows:

Dissolve 1.2 grams of steel in a porcelain dish with 25 cubic centimeters of a mixture of one part of concentrated sulphuric acid and four parts of nitric acid (1.2 specific gravity); boil down until fumes of sulphuric acid come off for two minutes while carbonaceous matter is being destroyed. Dissolve in hot water, and wash into a flask graduated to hold 300 cubic centimeters; add zinc oxide, held in suspension in water, shaking the flask during the operation, cool, dilute with cold water to the mark, mix thoroughly, and filter. Pour off 200 cubic centimeters of the filtrate, representing .8 grams of steel, into a 500 cubic centimeter flask, add one drop of nitric acid (1.4 specific gravity), and titrate with permanganate. Then $\frac{1}{1}$ of the strength in iron equals the strength of the permanganate in terms of manganese. The method should give fairly accurate results with good manipulation for steels low in carbon.

SILICON.

Dr. T. M. Drown's method is in general use. (Trans. Am. Inst Mining Engrs., Vol. VII., page 437, and Vol. VIII., page 508). The determination is simple and rapid:

Dissolve in nitric acid (1.2 specific gravity), add excess of sulphuric acid, and evaporate until fumes of sulphuric acid are giving off. Dissolve the ferric sulphate in water, and filter off the silica, washing with hot water and hydrochloric acid until free from iron; ignite, and weigh as silica.

amounts of carbon, as ordinarily determined for each heat, depend the existence of a sufficient number of tests and range of ca eliminate by average the effects of the other chemical elements accidents of manufacture and of test, while permitting the pro features to be brought out. Many changes must be adopted method of chemical analysis and physical tests in ordinary use works before anything like an adequate solution can be att Thus a different and more satisfactory method of carbon determ for structural steel, or a suitable modification of the prevailin test, is imperative; the adoption of a standard test piece is necessary; and, finally, the chemical determinations must be m from the little test ingot taken from the bath in the furnace, from the chip of a bloom during manufacture—though this is imm preferable to the former—but from the actual plate or bar subje physical test, and, if possible, from a test piece itself. The ne in well ordered works of immediate chemical analysis by which the furnaces is by no means so urgent as formerly considered. elements commonly analyzed for, carbon, manganese, and phos only the carbon can be rapidly determined, and the suitability metal to stand the physical requirements cannot be at all acc measured by such individual analysis as is commonly made. T disposition of the metal, if made subject to requirements, mus the results of the physical tests, and the connection between th dients and manipulation of the charge in the furnace and the p qualities of the wrought metal cannot be examined until the p tests are known.

These remarks apply to all special and structural steels made process. The system of most steel works in this respect is only to Bessemer rail, wire rod, or nail manufacture, or other loosely product, and needs radical change in the directions indicated reasonable certainty in the manufacture of high-grade special a ural steels is to be attained.

Of the steels manufactured under this inspection, the result chemical work done in connection with the Chester and Cambri have been kindly supplied by the manufacturers; the carbon a ganese of every heat of Norway steel were also readily suppli the chemistry of the Black Diamond steel nothing is known, ex given in the general statement of the materials used in its manu In the analysis of the Chester results, all the heats are not inclu complete chemical information had not been obtained when the for this steel were constructed. The chemistry of the Cambria very incomplete, even the carbon not being determined for eve The great variety of product of these works limits the amount o ical work for any one class of product, although collectively amount of chemical work is done and the laboratory is specia equipped; further, after a few careful analyses for a given class uct, much chemical work is not thereafter deemed necessary. rejected on a single test are not included in the table for th Except for a few special heats, no phosphorus determinations w plied for the Norway steel.

The pieces for chemical analysis of the Chester steel were te taken from the furnace during tapping.* For the Norway ste from the slabs as sent to the Bay State Works (see p. 410) were g used. For the Cambria steel, chips from a bloom—generally

* A piece of the test plate is now used at these works.

inches—were taken. The methods of chemical analysis in use at each of the above works have been given in connection with the manufacture of the steels, but are again stated under each heading.

The results of test for each percentage of carbon being averaged as given in the first columns of the tables, the corresponding spots were set off on the diagram, each marked with its number of heats. To obtain the mean curve the spots were taken in groups of three consecutively, thus: C. 10, C. 11, and C. 12; C. 11, C. 12, and C. 13; &c., and each spot having the weight corresponding to the number of heats of that carbon, the center of gravity of each group was obtained, giving a series of first derived spots. If these spots are not sufficiently regular to pass a curve, the method is repeated, obtaining a series of second derived spots. In general this is not necessary and can only be done at the sacrifice of local features, the tendency being evidently to flatten the curve. The solid drawn portions of the curves are considered well defined by the derived spots; the dotted terminals are probable.

The last columns in the tables give the results obtained from the curves, and the summaries show the leading features. The average changes for a point of carbon are taken as far as possible between points in the same phase on the successive hummocks or wave-like portions of the curves.

Of the Chester and Norway steels the tensile strength, ductility, and final area are the only properties plotted. For the Cambria steel, the elastic limit, elastic ratio—as obtained from the curves of ultimate strength and elastic limit—and the modulus of elasticity are added. The latter is drawn as a straight line, the irregularity of the spots and small number of heats not producing a sufficiently definite curve. Much importance is not to be given to it.

TABLE XLI.—*Drillings for analysis taken from small test ingot removed from th while tapping.*

CARBON PROPERTIES OF CHESTER STEEL.

[Chemical methods For combined carbon, the color test, dissolving a standard each time ganese, by dissolving in acid protosulphate of iron the binoxide precipitated from nitric tion by chlorate of potash and treating with permanganate of potash; for phosphorus precipitate method. Magnesia method occasionally used as a check.]

Number of heats	Carbon	Manganese	Phosphorus.	Average original sectional area.	Tests. Average ultimate tensile strength per square inch	Tests. Average final elongation.	Tests. Average final area.	Plotted c… Ultimate tensile strength per square inch.	Plotted c… Final elongation.
	Per ct.	*Per ct.*	*Per cent*	*Sq. inches*	*Lbs.*	*Per ct.*	*Per ct.*	*Lbs.*	*Per c*
1	.10	310	....	4586	62,050	24.62	50.05	....	29.0
6......	.11	.313	.0593 for 5	4937	55,724	29.28	39.92	56,000	28.2
7 .. .	12	351	0505 for 4	.6180	58,226	27.18	45.29	57,570	27.0
11	.13	340	0491 for 10	.5491	58,352	26.72	46.73	59,050	27.2
27 ...	14	.375	.0486 for 16	.5942	60,569	26.90	46.16	60,390	26.8
28	.15	384	.0518 for 21	.5719	61,618	26.75	46.16	61,530	26.5
24	.16	.393	0528 for 17	.5641	62,517	25.65	40.46	62,520	26.0
13	.17	.404	.0461 for 10	5492	63,339	25.89	50.46	63,600	25.6
5......	18	.416	.0487 for 3	.5710	65,169	24.81	46.71	65,150	25.1
6	.19	.447	.0548 for 5	.5812	67,062	24.69	51.60	67,100	24.7
1* .	.20	.410	.0300	.5109	59,000	29.27	41.85	....	24.4
1	21	.460	....	.7036	74,535	24.80	50.50	....	24.2
1	.22	.430	....	.5584	66,075	23.74	46.00	....	24.0

* Omitted as beyond the limits of error.

SUMMARY.

Number of heats (omitting .20 carbon)	190	
Average manganese......	.3813	per cent.
Average phosphorus	.0511	per cent. fo
Average original sectional area	.5702	square inch
Average increase of tensile strength per .01 per cent. carbon............	1,387.5	pounds.
Average decrease of final elongation per 01 per cent. carbon	.425	per cent.
Average increase of final area per 01 per cent. carbon....................	.600	per cent.

TABLE XLII.—*Drillings for analysis generally taken from slab 21 inches wide by 4 inches to 7 inches thick.*

CARBON PROPERTIES OF NORWAY STEEL.

[Chemical methods For combined carbon, the color test, for manganese a special volumetric process checked occasionally by the nitric acid and chlorate of potash method.]

Number of heats	Carbon	Manganese	Tests. Average ultimate tensile strength per square inch	Tests. Average final elongation.	Tests. Average final area.	Plotted curves. Ultimate tensile strength per square inch	Plotted curves. Final elongation	Plotted curves. Final area
	Per cent.	*Per cent.*	*Pounds.*	*Per cent.*	*Per cent.*	*Pounds.*	*Per cent.*	*Per cent.*
8	11	.363	58, 110	26. 75	50. 00	59, 500	26. 25	47. 40
29	12	377	60, 703	25. 66	47 35	60, 000	25. 65	48. 80
33	13	355	[illegible] 400	25. 27	49 40	61 300	25 50	49 50
36	14	[illegible]	61 514	25 84	49. 31	61, 620	25. 65	49. 00
53	15	[illegible]	61 884	25. 63	48. 03	61 780	25. 85	48. 70
31	16	[illegible]	61 850	26. 09	48. 61	61, 890	26. 00	48. 80
31	17	[illegible]	63 061	25 51	44 53	62, 110	25 60	49. 35
66	18	[illegible]	[illegible] 344	25. 49	48. 92	62, 670	25. 50	49. 10
40	19	[illegible]	[illegible] 340	25 08	47 58	62, 150	25. 20	48. 00
15	20	[illegible]	[illegible] 672	24 02	47 40	63, 700	24 80	47 60
10	21	421	65 660	24 67	49. 35	64, 030	24. 70	48. 40
11	22	403	63 260	24 61	49 00	64, 100	24 75	49. 50
7	23	407	64 020	25. 37	60 00	64, 280	25. 20	49. 30
1	24	440	62 253	28. 00	44 00	64, 460	25. 60	48. 30
1	.26	[illegible]	66, 639	25. 00	43. 00	65, 520	25. 35	48. 80
1	[illegible]	470	70, 132	24 00	49. 00	66, 200	24. 90	49. 25
1	31	390	[illegible] 754	25. 00	62. 00	67, 800	25. 25	52. 50

SUMMARY.

Number of heats	369
Average manganese	.3778 per cent.
Average phosphorus believed to be not above	06
Average increase of tensile strength per 01 per cent carbon	419 pounds.
Average decrease of final elongation per 01 per cent. carbon	.078 per cent.
Average increase of final area per 01 per cent. carbon	.116 per cent.

TABLE XLIII.—*Drillings for analysis generally taken from 7" by 7" bloom.*

CARBON PROPERTIES OF CAMBRIA STEEL.

[Chemical methods: For combined carbon, the color test; for manganese, the acetate of soda and bromine process; for phosphorus, the molybdate of ammonia and yellow precipitate method.]

Number of heats.	Carbon.	Average original sectional area.	Results of tests. Average elastic limit.	Average ultimate tensile strength.	Average elastic ratio.	Average final elongation.	Average final area.	Average modulus of elasticity.	Results from plotted curves. Elastic limit.	Ultimate tensile strength.	Elastic ratio.	Final elongation	Final area.	Modulus of elasticity.
	Pr ct.	*Sq. in*	*Lbs.*	*Lbs*	*Per ct*	*Per ct.*	*Per ct.*	*Lbs.*	*Lbs.*	*Lbs*	*Per ct*	*Per ct.*	*Per ct.*	*Lbs.*
1	.09	.5261	37,038	58,920	62.87	27.05	49.25	....	38,450	58,300	65.95	26.80	51.00	27,480,000
	.10	....	....	....	....	....	....	....	38,835	59,270	65.53	26.65	51.00	27,490,000
2	.11	.5584	41,450	61,544	67.35	25.86	50.88	27,930,000 for 1	39,230	60,250	65.10	26.45	51.00	27,500,000
6	.12	.5890	39,603	61,303	64.60	25.68	52.12	27,550,000 for 1	39,650	61,200	64.79	26.20	51.20	27,510,000
4	.13	.5636	40,222	61,366	65.55	26.76	47.75	25,920,000 for 1	40,060	62,100	64.52	25.95	51.35	27,520,000
24	.14	.5781	40,391	63,023	64.09	25.75	52.16	27,929,000 for 14	40,500	62,900	64.39	25.70	51.80	27,530,000
10	.15	.5476	41,642	63,610	65.30	25.24	51.59	27,092,000 for 9	40,960	63,600	64.40	25.50	52.25	27,540,000
22	.16	.5609	41,262	64,523	63.08	25.15	53.11	27,660,000 for 6	41,400	64,200	64.49	25.35	52.80	27,550,000
13	.17	.5698	41,818	63,915	64.64	25.39	53.50	28,304,000 for 5	41,800	64,700	64.70	25.20	53.30	27,560,000
13	.18	.5450	42,825	66,013	65.18	24.40	54.68	26,720,000 for 4	42,390	65,180	64.95	25.00	53.75	27,570,000
4	.19	.5410	42,650	63,475	67.19	26.03	53.95	28,540,000 for 2	42,800	65,650	65.20	24.80	54.10	27,580,000
8	.20	.5548	42,650	66,401	64.47	24.58	54.82	27,223,000 for 3	43,270	66,150	65.42	24.75	54.30	27,590,000
3	.21	.5306	45,541	67,947	67.02	24.13	52.16	....	43,770	66,600	65.72	24.70	54.80	27,600,000
1*	.22	.5640	39,000	63,220	61.83	24.83	56.77	28,840,000	44,250	67,100	65.95	24.70	54.10	27,610,000
2	.23	.5576	44,174	67,880	65.03	25.33	54.47	28,700,000	44,750	67,600	66.20	24.75	54.00	27,620,000
1	.24	.5396	42,210	66,125	63.84	24.85	51.67	28,140,000	45,250	68,125	66.43	24.80	53.80	27,630,000

* Omitted as beyond the limits of error. Subsequent analysis of a test piece gave .14 C.

SUMMARY.

Number of heats	120
Average manganese (believed to be) about	.450 per cent.
Average phosphorus (believed to be) about	.085 per cent.
Average original sectional area	.5577 square inch.
Average increase of elastic limit per .01 per cent. carbon	453 pounds.
Average increase of tensile strength per .01 per cent. carbon	653 pounds.
Average decrease of final elongation per .01 per cent. carbon	.132 per cent
Average increase of final area per .01 per cent. carbon	.187 per cent

The average steepness of the curves of tensile strength is very different, being especially great for the Chester steel. Other things being equal, the less mechanical work to which the material of the chemical sample has been subjected the steeper the curves should be, the effect of work of reduction being to increase the combined carbon, as shown by color tests,* but the conditions are so variable that this effect has never been quantified. Again, the condition of the metal in the little test ingot as used at Chester is not the same as in the plate ingots, cast and cooled under very different circumstances. Some idea of this effect may be obtained by considering the tensile strengths which would correspond to complete absence of carbon in each of the three steels. Carbonless Cambria steel, the other elements remaining the same, should have a tensile strength of about 53,250 pounds, with a possible error of about 1,000 pounds. The Norway steel should give about 55,750 pounds, with a possible error of about 750 pounds. The Chester steel would give the extremely low value of about 40,500 pounds, with a possible error of about 500 pounds. It is therefore probable that the Chester curve loses its steepness rapidly below .10 per cent. carbon.

The steepness of the curves would further appear to be influenced by the amounts of other elements present. Thus the Cambria and Norway steels had both been worked a good deal when the piece for chemical test was removed, the Cambria having received the most work, as it had also in the pieces tested. Yet the difference in steepness is sufficiently great to render it probable that the higher phosphorus and, perhaps, manganese of the Cambria steel have increased the rate of increase of strength per point of carbon.

It will also be observed that in the Chester steel, as well as, more imperfectly, in the Norway steel, increasing carbon is accompanied by increasing manganese, due probably to diminished oxidation in the furnace.

As possibly affecting the general character of the curves, the average sectional area was obtained for the Chester and Cambria steels. As has been shown (Plate VIII.), the apparent tensile strength of the Chester steel may be influenced by the proportions of the test piece, even with an 8-inch length. This effect seems to hold good in the curve for this steel, in which it will be noticed that the effect of correcting for difference of sectional area from the average value would be to bring the spots nearer the mean curve. No such result appears to hold for the Cambria steel.

For all the steels, the sinuous nature of the curves for tensile strength, ductility, and final area is the most notable feature apart from the differences of average steepness. This is particularly remarkable in the Norway steel. The humps and hollows agree very well in the various curves for the same steel. Thus a hump in tensile strength lies under a corresponding hump in final area and under a hollow in elongation. In other words, the intrinsic quality, as measured by efficiency number, has undergone a more gradual change with change of carbon than any single property. And in each steel this property will be found to have increased with increasing carbon, pointing to the advisability of using higher carbon metal as far as improving workmanship will permit.

The curves of Cambria steel are much increased in value by the curves of elastic limit and elastic ratio. Although the original spots for elastic limit appear somewhat irregular, the first derived spots lie

* Thus it is not uncommon for rail metal of about .40 carbon in the ingot to show 3 to 4 points higher in the bloom and 2 to 3 points higher yet in the finished section.

with almost perfect regularity on the curve drawn, itself the most regular of all the properties.

The derived curve of elastic ratio forms a very valuable basis from which to measure the physical condition of the metal as regards roll hardening from cold finishing, or rapid cooling after finishing, and possibly other disturbing causes. Under the average conditions of finishing, it is seen that for each carbon there is a corresponding value of elastic ratio, any departure from which measures the difference of physical condition from the average. Thus, if the elastic ratio be higher than corresponds to the observed tensile strength, it is strong evidence that the steel is intrinsically softer than as indicated by ultimate strength alone, and has been hardened in the rolls or in cooling. This effect may, however, be interfered with by comparatively small variations of other chemical elements besides carbon, notably phosphorus; and as illustrating the method by which these or similar curves obtained under more standard conditions may be employed for quantifying some of the conditions known to affect the physical tests of the metal, it may be as well to state the method of procedure in such a case.

In analyzing the results of physical test of a piece of steel of known chemical composition made and tested under standard conditions, it is first necessary to examine the elongation and final area for evidence of dirtiness or lamination in the piece—the fracture should also have been examined for evidences of lamination; if these two qualities are sufficiently near the average we may proceed, otherwise little useful result can be obtained. Departures from the average values of phosphorus and manganese are next examined, and it is here necessary to digress to note the nature of the effects produced by variations of these elements under ordinary circumstances.

As a hardener, phosphorus is generally considered to be even more effective than carbon, but its secondary effects are very different. Other things remaining the same, increase of phosphorus, besides raising the tensile strength, notably raises the elastic ratio, diminishes elongation, and more especially diminishes the reduction of area. Its effect in diminishing elongation, and probably also reduction of area, appears to be largely dependent on the amount of other elements present, especially of silicon. For convenience, the latter element must be supposed to vary little, and be present in quantity not above .04 per cent., as is common in open-hearth steels. The effect of phosphorus is then identical in nature to that of cold rolling or finishing, and is to be taken account of in much the same manner. Thus, in estimating the effect of departure from the normal elastic ratio, the influence of variations of phosphorus will have been taken account of. Further, high phosphorus metal is more influenced by cold rolling than steel with less of that element. Once quantified, under the condition of low silicon, the effect of a given absolute amount of phosphorus may probably be relied upon as practically constant.

Not so with the other most variable element, manganese. The basis from which the effect of variation is to be estimated is itself variable. To illustrate this, it is only necessary to make use of observed variations in the rolling quality of the metal, which is especially influenced by manganese. Thus, of two steels of precisely the same final composition with respect to carbon, phosphorus, manganese, and sulphur, but made from different stock, or in different ways, one may roll well and the other badly. What is sufficient manganese for one is insufficient for the other. This difference arises either from the different conditions in which the manganese may exist in the steel—the most prob-

able cause—or the variable amounts remaining of the oxide of iron whose hot-shortening effect the manganese counteracts. Under average conditions of any given method of manufacture, it is probable that a certain amount of manganese is necessary to prevent hot shortness, which may be called the *saturating* amount of manganese, while only the excess over this amount is free to influence the properties of strength and toughness. In different manufactures, the point of "saturation" of manganese will probably be different, while two heats of the same manufacture may be expected to vary from one another in this respect, depending on the stock and treatment in the furnace. The effect of excess of manganese above this point is certainly to increase the tensile strength, but its influence in other respects is not so decided.

To quantify the effects of phosphorus or manganese above or below the average amounts, we must have a few tests of steel varying only in the amount of one of these elements from the average, from which, by comparison with the carbon curve, a derived curve can be constructed for the effect of such variations.

The same method must be used to quantify the effect of departure from the normal elastic ratio previously corrected for variation of phosphorus.

By this method of comparison very fair results have been obtained from the Cambria curves, but the number of tests with special chemical determinations is too limited for perfect accuracy. Of these a few may be instanced. Thus,

(Piece 4503—1.)

Phosphorus	per cent..	.084
Manganese	do....	.488
Ultimate tensile strength	pounds..	69,230
Elastic limit	do....	50,000
Corresponding elastic ratio	per cent..	72.22
Final elongation	do....	20.00
Final area	do....	69.50

An inspection of these results shows, from the high elastic ratio, low ductility, and reduction of area, that the high tensile strength is due to cold finishing or other mechanical hardening, since the phosphorus and manganese are very near the average values. Careful determination of combined carbon in the test piece itself gave .14 per cent., for which the tensile strength should be 62,900 pounds, with a normal elastic ratio of 64.39 per cent. Thus the increase of elastic ratio to 72.22 per cent., or by 7.83 per cent., has raised the tensile strength 6,330 pounds. This increase of tensile strength with increase of elastic ratio is not probably at a uniform rate, but more rapidly as the elastic ratio rises.

Again,

(Piece 4875—1.)

Phosphorus	per cent..	.084
Manganese	do....	.208
Ultimate tensile strength	pounds..	55,400
Elastic limit	do....	33,210
Corresponding elastic ratio	per cent..	59.95
Final elongation	do....	28.60
Final area	do....	44.00

This steel shows low manganese and low elastic ratio, the latter probably corresponding to comparatively rapid and hot finishing. Accurate carbon determination of the test piece gave .10 per cent., for which the normal elastic ratio is 65.53 per cent. Estimating the effect of defect of

elastic ratio below normal value as somewhat less than that of excess, the difference of tensile strength corresponding to the defect of elastic ratio of 5.58 per cent. may be stated at about 3,000 pounds; or, under average conditions of finishing, the tensile strength would be about 58,400 pounds. As the tensile strength under these conditions, with average manganese, would be 59,270 pounds, the defect of .24 per cent. of manganese below the average of .45 per cent. diminished the tensile strength by not more than 870 pounds, provided none of the defect of elastic ratio is due to the low manganese. An equal excess of manganese above the average value has a much greater influence on the tensile strength, the *saturating* amount for this steel being believed to be near .40 per cent.

If we now consider the special tests of this steel taken from the deck-beam web, as given in Table XXXI.—the tests from the flat given in the same table have been mentioned as showing probable cold straightening or other treatment such that the elastic limit is not sufficiently marked—we have for the mean of the two pieces—*

Phosphorus	.080
Manganese (one piece)	.386
Ultimate tensile strength ..... pounds	63,017
Elastic ratio	61.18
Final elongation	26.00
Final area	55.16

This steel shows slight departure from average conditions in manganese, phosphorus, and elastic ratio. The defect of manganese of .064 per cent. may be credited with about 200 pounds tensile strength. The normal elastic ratio corresponding to the tensile strength so increased to 63,217 pounds is about 64.35 per cent. The defect, therefore, is to be taken as 3.17 per cent., probably affecting the tensile strength by about 1,000 pounds. So that bringing this steel up to the average conditions the tensile strength would be about 64,217 pounds, corresponding to .16 carbon. The carbon of one piece was .14 per cent. and of the other .16 per cent.

The above special cases have been considered only in order to clearly show the method of comparison. Many of the assumptions made, though formed on much more extended comparison, are still crude. Above all, the condition of the manganese is always uncertain, and something of the history of the stock and working in the furnace is necessary for any nice estimate of its effect. Nevertheless, the consistency of the physical and chemical condition of steel of this manufacture, tested as this was under fairly standard conditions, is truly surprising, and the method is highly suggestive of that which should be pursued in treating the results of steel of given manufacture tested physically and chemically under absolutely standard conditions, with special regard to the chemical determinations being made on the metal of the test piece itself. Under such circumstances alone can the complex influences affecting the behavior of a piece of steel be separately quantified and nicely balanced, and, from comparison of such results from steels of different manufacture, conclusions of the very highest interest may be also expected.

Combination or comparison of the curves obtained for the three steels is not possible with any accuracy, the conditions of physical treatment, manufacture, and carbon determinations being too widely different. It

* For particularly careful determinations of phosphorus and manganese in these and other pieces, the Board is much indebted to Mr. F. E. Bachman, chemist to the Phœnix Iron Company, and for specially determined carbons to Mr. T. T. Morrell, chemist to the Cambria Iron Company.

appears probable, however, that open-hearth mild steel of about .07 per cent. phosphorus, tested under the average conditions of this inspection, should show an average increase of tensile strength of not far from 650 pounds per square inch for an increase of .01 per cent. of carbon in the finished product with a simultaneous decrease of from .10 to .12 per cent. of final elongation in a piece of average dimensions, 60,000 pounds tensile strength and 27 per cent. elongation corresponding to about .10 per cent of carbon by color test in the test piece itself.* Large variations from these average results are to be expected from varying conditions of treatment and manufacture.

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* It has long been known that the rate of increase of tensile strength itself increases with increasing carbon.

APPENDIX.

TESTS FOR PLATE, BEAM, ANGLE, BULB, AND BAR STEEL, U BUILDING SHIPS FOR HER MAJESTY'S NAVY

ADMIRALTY, *November*

Strips cut lengthwise or crosswise to have an ultimate tensile strength of than 26, and not exceeding 30, tons per square inch of section, with an elonga per cent in a length of 8 inches The beam, angle, bulb, and bar steel to forge tests, both hot and cold, as may be sufficient, in the opinion of the officer, to prove soundness of material and fitness for the service.

Strips cut crosswise or lengthwise 1½ inches wide, heated uniformly to a red and cooled in water at 80° Fah., must stand bending in a press to a curve the inner radius is one and a half times the thickness of the steel tested

The strips are all to be cut in a planing machine, and to have the sharp ed off.

The ductility of every plate, beam, angle, &c., is to be ascertained by cation of one or both of these tests to the shearings, or by bending them the hammer.

All steel to be free from lamination and injurious surface defects

One plate, beam, or angle, &c , is to be taken for testing from every vided the number of plates, beams, or angles, &c., does not exceed fifty, that number, one for every additional fifty or portion of fifty Steel may or rejected without a trial of every thickness on the invoice.

The pieces of plate, beam, or angle, &c., cut out for testing are to be width from end to end, or for at least 8 inches of length

Plates will be ordered by weight per superficial foot the weight named be the greatest that will be allowed for ship plates and for boiler plates in width; a latitude of 5 per cent. below this will be allowed for rolling in inch in thickness and upwards and 10 per cent. in thinner plates In plates over 4 feet wide and ¼ inch thick and upward a latitude of 2½ per cent above per cent. below will be allowed for the springing of the rolls, and 5 per and 5 per cent. below will be allowed in thinner plates over 4 feet wide. The weight per foot of the plates ordered is to be ascertained by weighing not tons at a time when larger parcels than 10 tons are delivered; if these 10 to the due weight (calculated as stated above), or are more than the beforem percentage below it, the whole may be rejected In smaller deliveries th the average is to be ascertained by weighing the whole parcel The same as to latitude and mode of ascertaining weight apply also to other desc steel in the contract

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ADMIRALTY SPECIFICATIONS OF STEEL FOR BOILERS,

STEEL PLATES, BARS, RIVETS, &c.

The whole of the material used in boilers is to be obtained from steel mak names are to be submitted for approval. The steel is to be subject to the at the works of the manufacturer, under the supervision of the resident overseer.

TESTS FOR STEEL PLATES, ANGLE, TEE, AND BAR STEEL

The tests are as follows: Strips cut lengthwise or crosswise, to have an tensile strength of not less than 26 tons, and not exceeding 30 tons per squ

ection, with an elongation of 20 per cent. in a length of 8 inches. The angle, tee, nd bar steel and rivets to stand such forge tests, both hot and cold, as may be sufficient, in the opinion of the overseer, to prove soundness of material and fitness for he service intended.

Strips cut lengthwise or crosswise, 1½ inches wide, heated uniformly to a low herry-red, and cooled in water of 82° Fahr., must stand bending double in a press o a curve, of which the inner radius is one and a half times the thickness of the steel ested.

The strips are all to be cut in a planing machine, and to have the sharp edges aken off.

The ductility of every plate, angle, &c., is to be ascertained by the application of ne or both of these tests to the shearings, or by bending them cold by the hammer.

All steel is to be free from lamination and injurious surface defects.

The pieces of plate, angle, &c., cut out for testing are to be of parallel width from nd to end, or for at least 8 inches of length.

STEEL FOR FURNACES. TESTS.

The furnaces and combustion chambers are to be made of steel of special soft quality. n addition to the above tests, these plates are to be tested by welding and forging, nd some of the welded pieces are to be broken in the testing machine to ascertain he efficiency of the welding. The tensile strength of these plates must not exceed tons per square inch.

STEEL CASTINGS. TESTS.

All steel castings for engines are to satisfy the following conditions: Tensile trength between 28 and 32 tons per square inch, with an extension in 8 inches of ength of at least 10 per cent. Bars of the same metal 1¼ inches square should be apable of bending cold without fracture, through an angle of 90°, over a radius not greater than 2 inches. Test pieces are to be taken from each important casting.

ADMIRALTY INSTRUCTIONS FOR TREATMENT OF MILD STEEL.

(1) All plates or bars which can be bent cold are to be so treated; and if the whole ength cannot be bent cold, heating is to be had recourse to over as little length as possible.

(2) In cases where plates or bars have to be heated, the greatest care should be aken to prevent any work being done upon the material after it has fallen to the langerous limit of temperature known as a "blue heat"—say from 600° to 400° F. Should this limit be reached during working, the plates or bars should be reheated.

(3) Where plates or bars have been heated throughout for bending, flanging, &c., nd the work has been completed at one heat, subsequent annealing is unnecessary.

(4) Where simple forge-work has been done, such as the formation of the joggles, corners, and easy curves or bends, on portions of plates or bars, and the material has ot been much distressed, subsequent annealing is unnecessary.

(5) Plates or bars which have had a large amount of work put upon them while ot, and have had to be reheated, should be subsequently annealed. It is preferred hat this annealing should be done simultaneously over the whole of each plate or ar when this can be done conveniently. If it is inconvenient to perform the operaion of annealing at one time for the whole of a plate or bar, portions may be anealed separately, proper care being taken to prevent an abrupt termination of the ine of heat. If the severe working has been limited to a comparatively small part f a plate or bar, annealing may be limited to the parts which have been heated, the ame care being taken to prevent an abrupt termination of the line of heat.

(6) If desired, exceptionally long or quickly curved bars, such as frames, may be ormed of shorter pieces, with the butts suitably shifted and strapped.

(7) In cases where any bar or plate shows signs of failure or fracture in working, he details of the cases should be forwarded to the admiralty, in order that instrucions may be given as to the disposal of the bar or plate.

(8) It is not necessary to anneal plates or bars after punching, as a means of making good damage done in punching. For plating which forms an important feature n the general structural strength, such as the outer bottom plating, deck plating, leck stringers, &c., all butt straps shall have the holes drilled or be annealed after he holes are punched. In outer bottom plating, the holes, which are to be counterunk, should be punched about ⅛ inch less in diameter than the rivets which are used, he enlargement of the holes being made in the countersinking, which should in all ases be carried through the whole thickness of the plates.

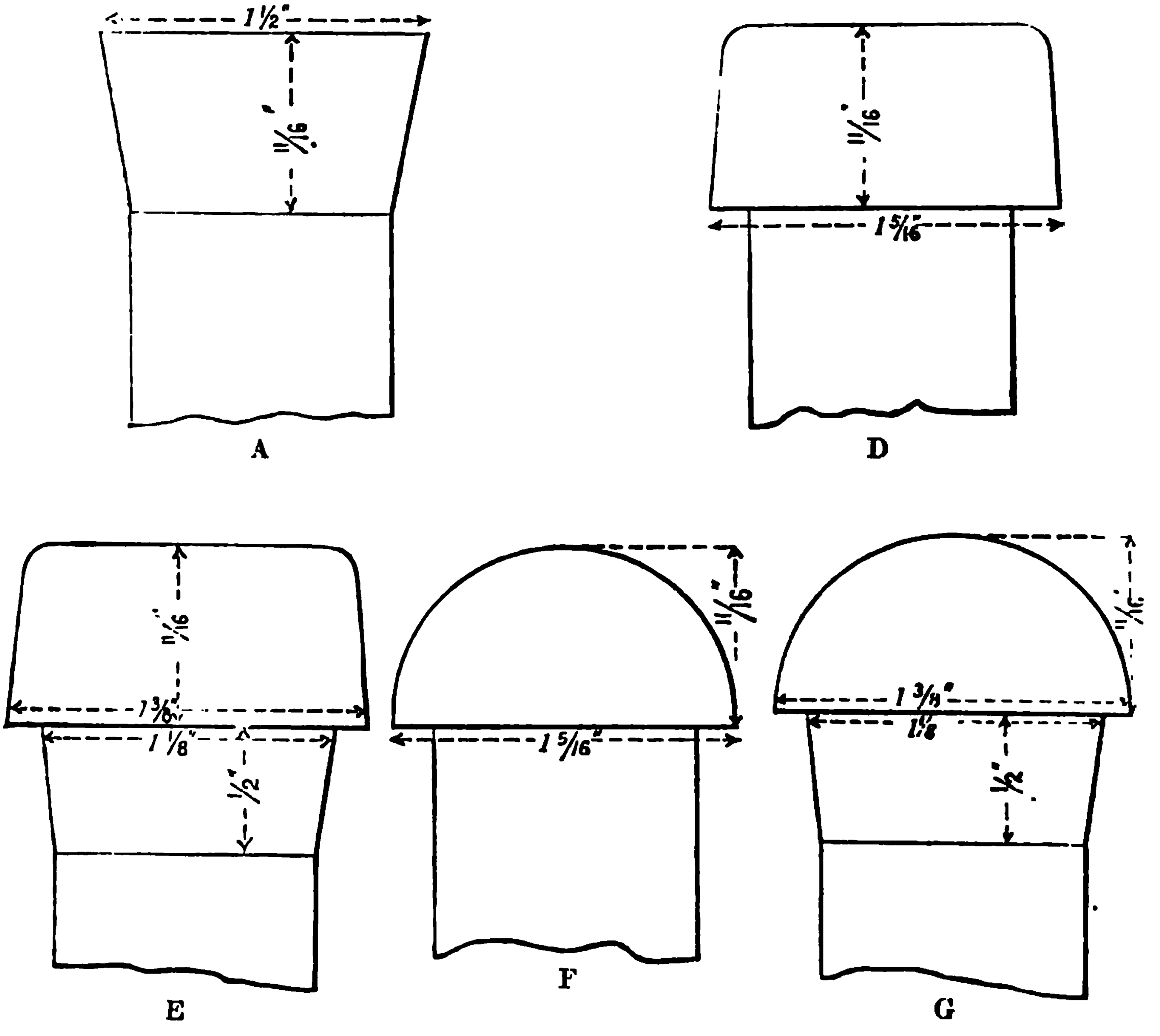
(9) Snap riveting is only to be employed for the internal work on transverse bulkheads, floors, framing, and other subordinate parts of the structure, but on stringers, deck plating, and other parts subjected to considerable tensile strain countersunk riveting is to be used, and the holes treated similarly to those in the outside plating.

(10) It is important that the whole surface of the bottom plating should be thoroughly cleared of the scale formed in manufacture before any paint or composition is put upon it. Detailed instructions as to the methods of removing the scale are given on NS. 3,590 of January 24, 1881.

ADMIRALTY, *September* 1, 1881.

BRITISH ADMIRALTY CODE OF TESTS FOR STEEL RIVETS.

(1) The rivets are to be made at the works of a firm approved of by the controller of the navy, and in strict accordance with the dimensions given in the schedule and with the drawings hereunto annexed. Each rivet is to be marked in one place with the broad arrow. They are to be supplied of any length demanded.



Drawings of 1-inch rivets of the several descriptions specified in the schedule herewith.

(2) The rivets are to be made from steel bars having an ultimate tensile strength of not less than 26 and not more than 30 tons per square inch, with a minimum elongation of 20 per cent. in a length of 8 inches. A portion of one bar to be taken for testing from every fifty, or portion of fifty, before making into rivets.

Pieces cut from every bar, heated uniformly to a low cherry-red, and cooled in water of 82° F. must stand bending in a press to a curve of which the inner radius is equal to the radius of the bar tested.

TESTS.

(3) The whole of the said rivets are to be properly heated in making, and care is to be taken that the finished rivets cool gradually. The rivets are to stand the following forge tests:

(*a*) Bending cold without fracture in the manner shown in Fig. 1 in the annexed diagram, where the line A B equals one diameter of the rivet.

(*b*) Bending hot without fracture in the manner shown in Fig. 2.

(*c*) Flattening of the rivet head, while hot, in the manner shown in Fig 3, without cracking at the edges. The head to be flattened until its diameter is 2½ times the diameter of the shank.

(*d*) The shank of the rivet to be nicked on one side and bent over to show the quality of the material.

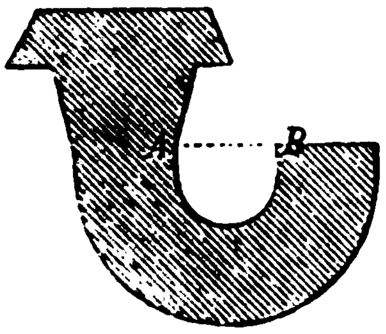


Fig. 1.

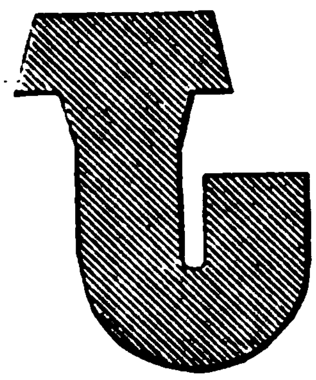


Fig. 2.

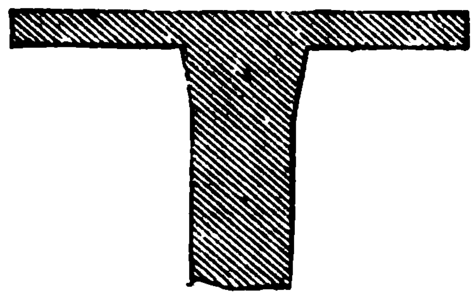


Fig. 3.

One rivet in every hundred to be forge-tested as a sample.

(4) Any such person or persons as their lordships shall from time to time direct or appoint shall be suffered to enter into and inspect the manufactory or works belonging to the maker of the rivets when the said rivets are being manufactured. And such inspector shall be at liberty to test the materal to be supplied, in any manner he may see fit, and a proper testing machine shall be kept at the works for this purpose, at the expense of the contractor. Rivets which have passed inspection by the inspector shall be marked by the contractor in any manner the inspector may desire, and when so marked shall not be subject to rejection.

The materials and labor necessary to carry out tests are to be found by the contractor.

Schedule of dimensions.

Diameter of rivet.	With pan or snap heads and straight necks to drawing D or F.		With countersunk heads to drawing A.		With pan or snap heads and conical necks to drawing E or G.			
	Diameter of head.	Depth of head.	Diameter of head.	Depth of head.	Diameter of head.	Depth of head.	Diameter under head.	Depth of cone.
Inch.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*
1⅜	1 15/16	1	....	....	2	1	1⅝	⅝
1¼	1 11/16	⅞	1¾	¾	1¾	⅞	1⅜	9/16
1⅛	1⅝	¾	1⅝	¾	1 9/16	¾	1¼	½
1	1 5/16	11/16	1½	11/16	1⅝	11/16	1⅛	½
⅞	1 3/16	⅝	1⅜	⅝	1½	⅝	15/16	7/16
¾	1 1/16	9/16	1⅛	7/16	1 5/16	9/16	13/16	⅜
⅝	⅞	½	1	5/16	⅞	½	11/16	5/16
½	¾	⅜	¾	¼	¾	⅜	9/16	¼
7/16	11/16	5/16	....	....	....	....	....	....
⅜	⅝	5/16	⅝	¼	....	....	....	....
5/16	½	¼	....	....	....	....	....	....
¼	7/16	3/16	....	....	....	....	....	....
3/16	⅜	⅛	....	....	....	....	....	....

TESTS FOR PLATE AND OTHER IRON USED IN BUILDING SHIPS FOR HER MAJESTY'S NAVY.

ADMIRALTY, *July* 3, 1880.

PLATE-IRON (FIRST CLASS).

B. B.

Tensile strain per square inch.—Lengthways, 22 tons; crossways, 18 tons.

Forge test (*hot*).—All plates of the first class, of 1 inch in thickness and under, should be of such ductility as to admit of bending hot to the following angles Lengthways of the grain, 125 degrees; across, 90 degrees.

Forge test (*cold*).—All plates of the first class should admit of bending cold, without fracture, as follows:

For plate-iron of first class, or B. B., and of middle class.

Thickness of plate.	With the grain. Through an angle of—	Across the grain. Through an angle of—	Thickness of plate.	With the grain. Through an angle of—	Across the grain. Through an angle of—
	°	°		°	°
1 inch	15	5	9/16 inch	30	12½
15/16 inch	15	5	½ inch	35	15
7/8 inch	20	7½	7/16 inch	42½	17½
13/16 inch	20	7½	3/8 inch	50	20
¾ inch	22½	10	5/16 inch	60	25
11/16 inch	25	10	¼ inch	70	30
5/8 inch	27½	12½			

PLATE-IRON (MIDDLE AND SECOND CLASS).

B.

Tensile strain per square inch.—Lengthways, 20 tons; crossways, 17 tons.

Forge test (*hot*).—All plates of the second class, of 1 inch in thickness and under, should be of such ductility as to admit of bending hot, without fracture, to the following angles: Lengthways of the grain, 90 degrees; across grain, 60 degrees.

Forge test (*cold*).—All plates of the second class should admit of bending cold, without fracture, as follows:

For plate-iron of second class, or B.

Thickness of plate.	Width of grain. Through an angle of—	Across the grain. Through an angle of—	Thickness of plate.	Width of grain. Through an angle of—	Across the grain. Through an angle of—
	°	°		°	°
1 inch	10	....	9/16 inch	25	7½
15/16 inch	10	....	½ inch	30	10
7/8 inch	15	....	7/16 inch	37½	12½
13/16 inch	15	....	3/8 inch	45	15
¾ inch	17½	5	5/16 inch	55	17½
11/16 inch	20	5	¼ inch	65	20
5/8 inch	22½	7½			

Plates, both hot and cold, should be tested on a cast-iron slab, having a fair surface, with an edge at right angles, the corner being rounded off with a radius of half an inch.

The portion of the plate tested, for both hot and cold tests, is to be 4 feet in length, across the grain, and the full width of the plate with the grain.

The plate should be bent at a distance of from 3 to 6 inches from the edge.

It is intended that all the iron shall stand the forge tests herein named, when taken four-feet in lengths, across the grain, and the whole width of the plate along the grain, whenever it may be necessary to try so large a piece, but a smaller sample will generally answer every purpose.

All plates to be free from lamination and injurious surface defects.

One plate to be taken indiscriminately for testing from every thickness of plate sent in per invoice, provided they do not exceed fifty in number, or portion of fifty.

Where plates of several thicknesses are invoiced together, and there are but few plates of any one thickness, a separate test for plates of each thickness need not be made; but no lot of plates of any one thickness must be rejected before one of that lot has been tested.

MOLDED IRON.

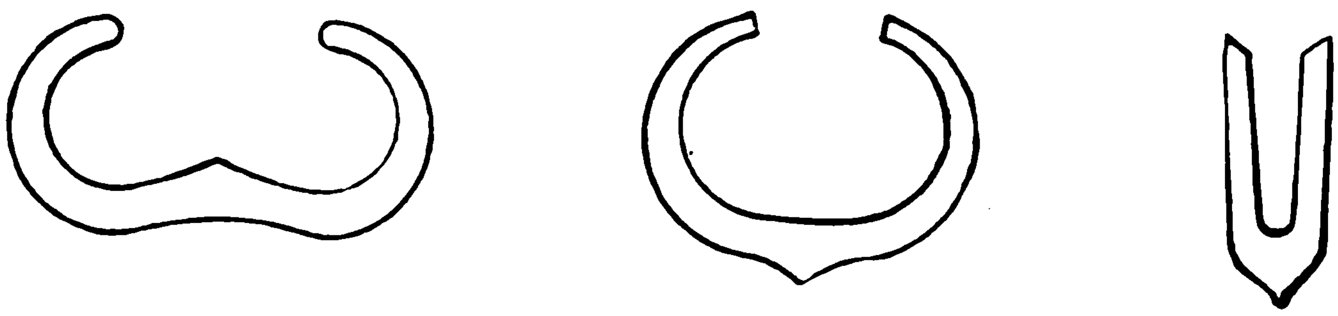
Including angle, bulb, tee, angle-bulb, tee-bulb, channel, and other descriptions of molded iron of ordinary form.

Tensile strain per square inch with the grain, for every description, 22 tons.

The ductility and other qualities of the iron should be such as to admit of its being bent hot and cold in the following manner, without fracture:

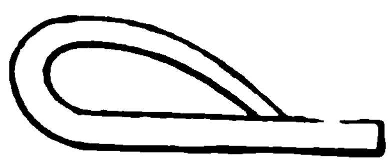
ANGLE-IRON.

Forge test (*hot*).—Angle-iron should be tested hot by being bent, thus:

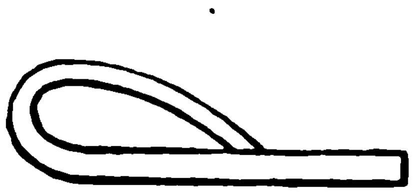


and also by being flattened, thus:

and the end bent over, thus:



Forge test (*cold*).—Angle-iron should also be notched and broken across cold, to show the quality of the iron, and one flange should be cut off and bent cold, thus:



TEE-IRON.

Forge test (*hot*).—Tee-iron should be tested hot by being bent, thus:

Forge test (*cold*).—The cold test for tee-iron should be similar to that for angle-iron.

TEE-BULB IRON.

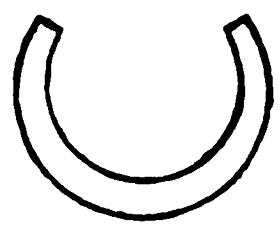
Forge tests (*hot and cold*).—Tee-bulb iron should be tested hot by cutting off the bulb and testing the remainder in the same manner as tee-iron, and the bulb should be notched on one side and broken cold to show the quality of the iron.

ANGLE-BULB IRON.

Forge tests (*hot and cold*).—Angle-bulb iron should be tested in the same manner as angle-iron, after the bulb has been cut off, and the bulb itself should be tested similarly to that of the tee-bulb iron.

BULB IRON.

Forge tests (*hot and cold*).—Bulb iron should be tested hot by cutting off the bulb and bending with the web across the grain, thus:



and the bulb should be notched on one side and broken cold, to show the quality of the iron.

CHANNEL IRON.

Forge tests (*hot and cold*).—Channel iron should be tested hot by being bent thus:

and one of the flanges should be cut off and bent cold, as for angle iron. A sample should be notched and broken cold, to show the quality of the iron.

OTHER DESCRIPTIONS OF MOLDED IRON.

Other descriptions of molded iron should be tested in a similar manner to the foregoing, according to the form.

All molded iron to be free from lamination and injurious surface defects.

One sample should be taken indiscriminately for testing from every description of molded iron included in one invoice, provided the number of bars of the same kind so included does not exceed fifty; and if this number is exceeded, one sample is to be taken for every additional fifty or portion of fifty.

BAR AND OTHER IRON.

Including flat or round bar, molding, sash-bar, half-round, and segmental iron, nail-rod iron, hoop-iron, &c.

In this kind of iron that marked "Best Best" should in every case stand a tensile strain, with the grain of 22 tons per square inch, and the whole of the iron should stand such forge tests, both hot and cold, as may be deemed expedient.

The foregoing tests, and such others as may be considered necessary by the controller of the Navy and the overseer, are to be carried out by, and at the expense of, the ship contractors.

TESTS FOR BOILER-PLATE IRON.

***Tensile strain** per square inch.*—Lengthways, 21 tons; Crossways, 18 tons.

***Forge test** (hot).*—All plates of one inch in thickness and under should be of such ductility as to admit of bending hot, without fracture, to the following angles: Lengthways of the grain, 125 degrees; across the grain, 100 degrees.

Forge Test (cold).

Thickness of plate.	With the grain. Through an angle of—	Across the grain. Through an angle of—
	°	°
1 inch	15	5
$\frac{15}{16}$ inch	17.5	6.5
$\frac{7}{8}$ inch	20	7.5
$\frac{13}{16}$ inch	22.5	9
$\frac{3}{4}$ inch	25	10
$\frac{11}{16}$ inch	28	11.5
$\frac{5}{8}$ inch	32.5	12.5
$\frac{9}{16}$ inch	37.5	14
$\frac{1}{2}$ inch	42.5	17.5
$\frac{7}{16}$ inch	48.5	20
$\frac{3}{8}$ inch	55	25
$\frac{5}{16}$ inch	65	30
$\frac{1}{4}$ inch	75	35

REQUIREMENTS FOR STEEL FOR HULLS AND BOILERS OF SHIPS FOR THE FRENCH NAVY.

[No. 52.—The minister of marine and of the colonies to the vice-admirals commanding in chief, maritime prefects, the directors of the establishment d'Indret, and the Forges de la Chaussade. *Second direction*, material; fourth bureau, general supplies: first bureau, naval construction.]

Classification of steel plates and rolled bars—Instructions as to their use and the tests to which they are to be subjected for acceptance.

PARIS, *February* 9, 1885.

GENTLEMEN: The somewhat extended trial which the navy has made of the circular of May 11, 1876, modified by that of May 7, 1877, permits me to state that the conditions relating to the tensile tests, besides assigning practically too narrow limits to the manufacture, correspond to a quality of steel which was not always sufficiently mild for the purpose intended.

The progress realized for several years in this branch of metallurgy has led me to omit from the new circular the gradations of price assigned to the different classes of steel plates; they were exaggerated, and would occasion, if continued, a sensible loss to the treasury. It is sufficient, in taking account of the difficulties of manufacture, to establish wide divisions, much more simple, for each of which the contractors must fix distinct prices in their tenders.

The new circular contains also certain modifications of less importance, which will be made sufficiently evident by a comparative examination.

Consequently I have decided that the following instructions shall replace those of May 11, 1876, and of May 7, 1877. Its insertion in the official bulletin of the navy will be sufficient notification.

Receive, &c.,

A. PEYRON.

Classification of plates, and of strips and straps, according to their dimensions.

(February 9, 1885.)

Plates are defined by a width greater than 400 millimeters (15¾ inches). The denomination of strips and straps [bandes ou couvre-joints] is reserved for those whose width does not exceed 400 millimeters.

SUBDIVISION OF PLATES.

Plates will form four divisions—thin plates, medium plates, thick plates, and extra wide thick plates—as follows:

(1) *Thin* plates, from 1½ millimeters [.059 inch] thick to 4 millimeters [.1575 inch], exclusive, of 1.60 meters [63 inches] maximum width and 7 meters [22 feet 11 inches] maximum length.

(2) *Medium* plates, from 4 millimeters [.1575 inch] to 8 millimeters [.315 inch] thick, exclusive of 1.80 meters, [70⅞ inches] maximum width and 8 meters [26 feet 3 inches] maximum length.

(3) *Thick* plates, from 8 millimeters [.315 inch] thick and above, of 1.80 meters [70⅞ inches] maximum width, and 10 meters [32 feet 9⅞ inches] maximum length.

(4) *Extra wide thick* plates of 8 millimeters [.315 inch] and over in thickness between 1.80 meters [70⅞ inches] and 2.10 meters [82⅝ inches] wide, and a maximum length of 10 meters [32 feet 9⅞ inches].

Plates not rectangular, but with straight sides, may be demanded, and will be paid for at the rate of 3 francs per 100 kilograms [about ¼ cent per pound] more than the rectangular plates from which they were cut.

SUBDIVISION OF STRIPS AND STRAPS.

(1) *Thin* strips, from 1½ millimeters [.059 inch] to 4 millimeters [.1575 inch], exclusive, and of 7 meters [22 feet 11⅝ inches] maximum length.

(2) *Medium* strips, 4 millimeters [.1575 inch] to 8 millimeters [.315 inch] thick, exclusive, and of 8 meters [26 feet 3 inches] maximum length.

(3) *Thick* strips, 8 millimeters [.315 inch] and over thick, and of 10 meters [32 feet 9⅞ inches] maximum length.

Forms of tenders, inserted after the conditions of contract, will be made so that bidders may affix a price for each of these subdivisions.

Extra thin plates and strips below 1½ millimeters [.059 inch] thick, and thin, medium, and thick plates and strips, which, by their width and length, may not be comprised in the above classification, will be the subject of special contracts.

TESTS OF ACCEPTANCE.

To insure the quality of steel plates and strips, three kinds of tests will be made: (1) cold tests; (2) hot tests; (3) temper tests.

(1) *Cold tests.*—The object of these tests will be to determine the resistance of the metal to rupture and its capacity for elongation both with and across the grain (always provided the width is sufficient).

The mean results of resistance and elongation in these two directions will be separately obtained, by at least five tests for each.

For these tests, pieces will be cut from a certain number of sheets or strips taken at random from each delivery. These pieces will be fashioned so as to have a rectangular section of which the smaller side is the thickness of the piece, and the longer side will be 30 millimeters [1.181 inch] for plates of 4 millimeters [.1575 inch] and over, and 20 millimeters [.7874 inch] for plates of less than 4 millimeters [.1575 inch]. *i. e.*, for plates called *thin*. However, for plates of 20 millimeters [.7874 inch] and over, the width should be equal to the thickness, so that the section of the piece will be a square of side equal to the thickness.

The length of the prismatic portion taken for tension will be always exactly 20 centimeters (7.874 inches) laid off by two punch marks, and terminating in fillets, so that rupture may always take place between the punch marks.

On no account may the pieces be reheated after being removed from the sheets.

Each piece shall be subjected to an initial load determined so as to produce a stress equal to eight-tenths of the breaking stress calculated according to the accompanying tables. This first load will be maintained in action for one minute, unless the piece continues to stretch after this lapse of time, when no further load will be added until the elongation ceases.

At intervals of a quarter of a minute successive loads will be added of one-half kilo-

gram per square millimeter (711 pounds per square inch); these intervals may always be prolonged when necessary, *i. e.*, so that no additional load may be added while the piece continues to stretch under the preceding load. The elongation corresponding to each load will be noted as measured on the length of 20 centimeters between punch marks.

No test piece considered satisfactory is to break under the initial load, whatever the corresponding elongation; nor give a final elongation less than eight-tenths of the final elongation demanded, whatever may be the corresponding breaking load.

The least mean breaking loads per square millimeter of original section, and the least elongations per cent. demanded of pieces subjected to test, are given in the annexed Table I. for plates, and in Table II. for strips and straps.

It will be observed that for plates no distinction is made between the results demanded with and across the grain. The figures of Table I. are to be obtained for both directions.

Not so for strips. Here, indeed, from the method of rolling, the strength and elongation with the grain should be greater than across it; besides, for narrow strips, in most cases test pieces cannot be taken across the grain. Accordingly Table II. has different figures for the two cases.

TABLE I.—*Plates.*

Thickness.		Ship plates. Least mean stress.		Ship plates. Least mean final elongation.	Boiler plates. Least mean stress.		Boiler plates. Least mean final elongation.
Millimeters.	*Inches.*	*Kilos. per sq. mm.*	*Lbs. per sq. inch.*	*Per cent.*	*Kilos. per sq. mm.*	*Lbs. per sq. inch.*	*Per cent.*
1½ to 2 ...	.059 to .079, exclusive. ..	47	66,830	10	....	....	....
2 to 3 ...	.079 to .118, exclusive ..	46	65,420	13	....	....	....
3 to 4 ...	.118 to .1575, exclusive ..	45	63,990	16	....	....	....
4 to 6 ...	.1575 to .236, exclusive ...	45	63,990	18	45	63,985	22
6 to 8 ...	.236 to .315, exclusive ...	43	61,150	21	42	59,720	25
8 to 20 ...	.315 to .787, exclusive ...	42	59,730	22	42	59,720	26
20 to 30 ...	.787 to 1.181, inclusive....	42	59,730	24	40	56,880	26

A reduction will be allowed in the least mean resistance up to 2 kilograms (2,844 pounds) provided this deficiency is compensated for by such an increase of elongation that the sum of the resistances and elongations is not less than as given in the table.

Not the least reduction of elongation will be allowed.

TABLE II.—*Strips or straps.*

Thickness.		Lengthways. Least mean stress.		Lengthways. Least mean final elongation.	Crossways. Least mean stress.		Crossways. Least mean final elongation.
Millimeters.	*Inches.*	*Kilos. per sq. mm.*	*Lbs. per sq. inch.*	*Per cent.*	*Kilos. per sq. mm.*	*Lbs. per sq. inch.*	*Per cent.*
1½ to 4 ...	.059 to .1575, exclusive ..	47	66,830	13	45	63,990	12
4 to 6 ...	.1575 to .236, exclusive ...	46	65,410	19	44	62,570	17
6 to 8 ...	.236 to .315, exclusive ...	44	62,570	22	42	59,720	20
8 to 20 ...	.315 to .787, exclusive ...	43	61,140	23	41	58,300	21
20 to 30 ...	.787 to 1.181, inclusive....	43	61,140	25	41	58,300	23

A reduction will be allowed in the least mean resistances to the same extent and with the same compensation of elongation as for plates.

(2) *Hot tests.*—The test will consist in forming from a piece of plate of suitable dimensions a hemispherical cup, with a flat rim retained in the original plane of the plate.

The diameter of the hemisphere, measured on the inside, is to be equal to forty times the thickness of the plate, and the width of the flat circular rim is to be ten times this thickness. This flat rim is to join on to the spherical part by a bend, of which the radius, measured on the inside of the angle, shall be, at most, equal to the thickness of the plate.

Besides this, for plates of more than 5 millimeters thickness there shall be fashioned a box with a square base, with the sides at right angles with the plane of the plate; the base of this box shall have for its side thirty times the thickness of the plate, and the raised rims, measured on the inside, shall have for their height ten times this thickness. The bottom of this box shall be pierced in the middle with a circular hole, with edges raised at right angles to the plane of the bottom, and on the opposite side to that of the rim of the box. The diameter of this hole, measured on the inside after the work is done, is to be twenty times the thickness of the plate, and the height of the raised edge is to be five times this thickness. All angles are to be rounded, their internal bend having for radius the thickness of the plate.

The pieces so fashioned, with all the precautions required in working steel, must present neither flaws nor cracks even after cooling in a strong current of air.

The box test is not obligatory, but is left to the discretion of the engineer in charge.

(3) *Temper test.*—For these trials, pieces will be cut from the sheets presented for acceptance 26 centimeters (10¼ inches) long by 4 centimeters (1.575 inches) wide, both with and across the direction of rolling; for strips and straps they will be taken only lengthways. The pieces prepared for these tests are not to have their long edges rounded off, the only treatment permitted being to remove the sharpness of the edges with a fine file. They will be uniformly heated so as to be brought to a low cherry red, and then plunged in water at 28° centigrade. Thus prepared they are to take under a press, without sign of rupture, a permanent bend of least internal radius not exceeding the thickness of the piece tested.

Similar pieces when taken from boiler plates must stand, under a press, without sign of rupture, being folded over flat, so that the two halves shall be in perfect contact with one another.

Plates which will not satisfy the conditions detailed above will be rejected.

ROLLED BARS.

To insure the quality of the different kinds of rolled bars of steel, three kinds of tests will be made as for plates: cold tests, temper tests, and hot tests.

(1) *Cold tests.*—The object of these tests will be to determine the resistance of the metal to rupture and its capacity for elongation. For this purpose, pieces will be cut from the webs under the same conditions as for steel plates. The thickness shall be that of the webs, the width the same as for steel plates of the same thickness, *i. e.*, 30 millimeters for webs of 4 millimeters in thickness and over, and 20 millimeters for webs less than 4 millimeters thick.

The initial load will be determined so as to produce a tensile stress equal to eight-tenths of the breaking stress calculated from the following table.

The tests will be then conducted as prescribed for plates.

No piece considered satisfactory is to break under the initial load nor give a final elongation less than eight-tenths of the mean final elongation required.

The least mean stresses per square millimeter of original section, under which the pieces may break and the corresponding least elongation are given in the following table:

Thickness of webs.		Angles, bulb-bars, and plain T-bars.			Bulb-beams H, U, and Z-bars.			Angles for boilers.		
		Least mean stress.		Least mean final elongation.	Least mean stress.		Least mean final elongation.	Least mean stress.		Least mean final elongation.
M. m.	*Inches.*	*Kilos per sq. m. m.*	*Lbs. per sq. in.*	*Per ct.*	*Kilos per sq. m. m.*	*Lbs. per sq. in.*	*Per ct.*	*Kilos per m. m.*	*Lbs. per sq. in.*	*Per ct.*
2 to 4	.079 to .1575, exclusive...	46	65,410	18	46	65,410	16	....	....	....
4 to 6..	.1575 to .236, exclusive..	44	62,570	22	44	62,570	20	46	65,410	22
6 to 8 .	.236 to .315, exclusive ...	44	62,570	22	44	62,570	20	44	62,570	26
8	.315 and over...........	42	59,720	24	44	62,570	22	42	59,720	26

The same reduction of 2 kilograms in the minimum breaking stresses is allowed as for plates, under the same conditions of increase of the corresponding final elongation. No reduction whatever is allowed in the elongations.

(2) *Temper tests.*—For these tests there shall be cut from the webs of bars presented for acceptance strips 26 centimeters ($10\frac{1}{4}$ inches) long and 40 millimeters (1.575 inches) wide, with the same precautions as for plates. As for the latter, they will be heated to a low cherry red and plunged into water at 28° centigrade. They must be able to take under a press a permanent set of internal radius not greater than $1\frac{1}{2}$ times the thickness of the bar tested, except for angles for boilers. These must stand being bent to an inner radius at least equal to their thickness.

(3) *Hot tests.*—Angles will be subjected to the following tests:

A piece cut from the end of a bar taken at random from each delivery shall be formed into a ring such that one flange remaining in its own plane, the other flange forms a cylinder of internal diameter equal to three and a half times the width of the flange remaining flat. A piece cut from the end of another bar shall be opened out until the two faces are practically in the same plane. A piece from the end of a third bar shall be closed until the two flanges are in contact. The angles subjected to these tests must show neither cracks, clifts, nor flaws.

Channel (⊔) and Z bars will be subjected to the same tests, the middle web being split for a suitable distance so as to get an angle with equal flanges.

Single T bars will be subjected to the following tests:

A piece cut from the end of a bar taken at random from each delivery shall be formed into a half ring such that the central flange remaining in its own plane the other may form a half cylinder of internal diameter equal to 4 times the depth of the T.

At the end of another bar taken by chance from the same delivery the central flange will be split up the middle for a length equal to 3 times the total depth of the bar and a hole drilled at the end of the slit to prevent its spreading; the piece so separated shall be opened out in its own plane to an angle of 45° with the other flange. Care must be taken to keep the flange opened out reasonably straight, it qeing joined on to the rest of the bar with a curve of small radius.

The bars subjected to these tests must show neither cracks, clifts, nor flaws.

Bulb T and I beams will be subjected to the following tests: At the end of a bar selected at random from each delivery, the central web will be split up the middle for a length equal to three times the total depth of the bar, and a hole drilled at the end of the slit to prevent its spreading; then one of the two parts shall be opened out at one or more heats, the central flange remaining in its own plane, so that the two pieces make an angle of approximately 45° with each other. For bulb bars the part bent out shall be that which carries the bulb. Care must be taken to keep the part worked sensibly straight, and to join it on to the rest of the bar with a curve of small radius.

Angles and molded bars which will not satisfy these conditions will be rejected.

A. PEYRON.

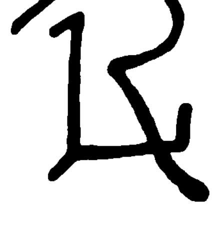
Minister of Marine and of the Colonies.

PARIS, *February* 9, 1885.

TESTS OF STEEL REQUIRED BY LLOYD'S REGISTER OF BRITISH AND FOREIGN SHIPPING.

The steel to be used in ships building for classification in the register book will be required to withstand the whole of the following tests, to be applied at the steel works under the personal inspection of the society's surveyors, to samples selected by them from every charge or cast employed in the manufacture of the material, and these samples, when marked by them for testing, should be followed by the surveyors through the different stages of preparation until the tests are completed.

The committee will require that every plate, beam, and angle supplied for these ships shall be clearly and distinctly stamped by the manufacturer in two places, where the brand cannot be conveniently sheared off, after they have been tested, the brand to be similar to the following, thus: Denoting that a shearing from the plate or an-



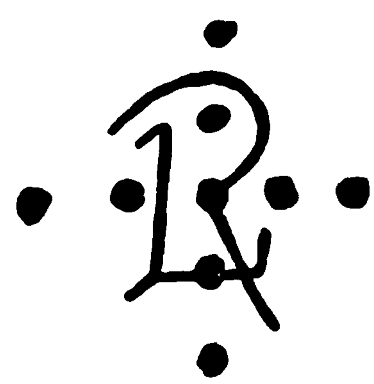
gle so marked has successfully been bent cold after being tempered as described in the temper test which follows, and that the plate or angle in question is capable of withstanding the whole of the tests hereafter described; and the committee will require the surveyors when in constant attendance at the steel works to satisfy themselves, so far as may be practicable, that these conditions are being complied with in a *bona fide* manner.

Should the samples selected by the surveyor not fulfill the test requirements, the plates or angles from which they were cut are to be rejected, and further tests are to be made before any material from the same charge can be accepted.

When one of the society's surveyors is not in constant attendance at the steel works for the purpose of seeing the material tested, the committee will require that tensile and temper tests shall be applied either at the steel works or at the ship-yard to not less than one plate, angle bar, or bulb plate, in every batch of 50, or a batch of less number; but the surveyor is not to select samples for testing until the material has been tested, stamped, and appropriated by the manufacturer. The samples when marked by the surveyor for testing are to be followed by him when practicable through the different stages of preparation until the tests are completed. Should the samples tested not fulfill the test requirements, the whole of the material from the charge which produced the samples which failed to withstand the tests prescribed is to be rejected or retested, and further tests are to be applied to a sample from each of the other charges of which the batch is composed. In the event of any of these samples also failing, the whole of the material from the same charge or charges is to be rejected as in the first instance.

Before these sample tests have been applied to a batch of steel submitted for check testing, the surveyor is to be furnished with a certificate by the manufacturer to the effect that the society's requirements as to the testing of steel have been complied with in the case of the batch in question.

In the event of material failing, in any case, to withstand the prescribed tests, the brands approved by the committee and stamped on the plates, beams, and angles by the manufacturer are to be defaced by punch marks extending beyond the brand in the form of a cross, thus: denoting that the material is rejected.



The society's surveyor will require to have every facility placed in his way for tracing all plates, beams, and angles to their respective charges, and to be furnished with two copies of the advice notes of the material, one of which, when he shall have been satisfied with the results of the tests applied to the material, he is to sign, to be forwarded by the manufacturers to the ship-builders, and the other of which is to be retained by himself.

TESTS.

Strips cut lengthwise or crosswise of the plate, and also angle and bulb steel, to have an ultimate tensile strength of not less than 27, and not exceeding 31 tons per square inch of section,* with an elongation equal to at least 16 per cent. on a length of 8 inches before fracture.

Strips cut from the plate, angle or bulb steel, to be heated to a low cherry-red, and cooled in water of 82° Fahrenheit, must stand bending double round a curve of which the diameter is not more than three times the thickness of the plates tested.

In addition to this, occasional angle bars should be subjected to a cold test by having pieces cut off and bent flat and then doubled backwards.

RIVETS.

The steel used for rivets to be of special quality, soft and ductile, and samples of the rivets should be tested by being bent both hot and cold, by flattening down the

* Steel angles intended for the framing of vessels, and bulb steel for beams, may have a maximum tensile strength of 33 tons per square inch of section, provided they be capable of withstanding the bending tests, and of being efficiently welded.

MEM.—No reduction will be allowed in the sizes of rivets from those which would be required by the rules for the vessels if built of iron.

heads, and by occasional forge tests, in order to satisfy the surveyors of their thorough efficiency.

BOILERS MADE OF STEEL.

The use of steel will be sanctioned in the construction of boilers intended for vessels classed or proposed for classification in the Society's Register Book, provided the boilers be constructed in accordance with the requirements of the rules, and the following conditions be fulfilled.

The material is to have an ultimate tensile strength of not less than 26 and not more than 30 tons per square inch of section, with an ultimate elongation of not less than 20 per cent. in a length of 8 inches. It is to be capable of being bent to a curve, of which the inner radius is not greater than one and a half times the thickness of the plates or bars, after having been heated uniformly to a low cherry-red and quenched in water of 82° F.

Steel rivets are to be considered as part of the material, and in addition to being subjected to a shearing test, they must be capable of withstanding the same tests as the plates are required to undergo.

Samples for testing are to be selected from each batch of plates submitted for approval, care being taken in the selection that, as far as possible, each cast or furnace charge, from which the material has been produced is represented. In addition to these tests, the temper test is to be applied to samples taken from *every* plate intended to be used in the furnaces and combustion chambers of the boilers.

The society's surveyor will attend at the steel works when necessary, and select the samples for testing before the plates are sheared to size, and these samples when marked by him for testing should, as far as practicable, be followed by the surveyor through the different stages of preparation until the tests are completed.

The society's surveyor will require to have every facility placed in his way for tracing all plates to their respective charges, and to be furnished with two copies of the advice notes of the material, one of which, when he shall have been satisfied with the results of the tests applied to the material, is to be signed and forwarded to the boiler manufacturer, and the other is to be retained by himself.

The samples are taken for testing in order that the general quality of the material may be ascertained, and if any sample should fail to fulfill the conditions laid down, the plate from which the sample is taken must be rejected; and further tests should be made before any material made from the same cast or charge as the failing sample can be approved.

All the holes in steel boilers should be drilled, but if they be punched the plates are to be afterwards annealed.

All plates that are dished or flanged, or in any way heated in the fire for working, except those that are subjected to a compressive stress only, are to be annealed after the operations are completed.

No steel stays are to be welded.

Unless otherwise specified, the rules for the construction of iron boilers will apply equally to boilers made of steel.

"LIVERPOOL UNDERWRITERS' REGISTRY." (RULES FROM SEPTEMBER 1, 1882, to AUGUST 31, 1883.)

VESSELS BUILT OF STEEL.

SECTION 24. The whole of the material used in construction of the hulls of such vessels, except where otherwise specified, or by special sanction of the committee, must be of steel of "mild" quality, and capable of withstanding the following tests:

Samples are to be selected by the surveyor, in such numbers as he may deem necessary, but samples must be taken at least from every cast, and from every fifty plates or bars, and tested as follows:

Strips cut lengthways and crossways of plates, and lengthways of bulbs, bars, and angles, are to have an ultimate tensional resistance of not less than 30 tons per square inch. The prepared parallel part of the tension sample must not be less than eight inches long. Strips cut lengthways and crossways of plates, and lengthways of bulbs, bars, and angles, are to be heated to a full red and quenched in water, and then bent cold double without fracture, with a curvature of which the inner radius does not exceed one and a half times the thickness of the sample.

Strips with sheared edges undressed, heated and quenched as above described, and similar strips without any tempering, are, at the discretion of the surveyor, to

tested by being bent cold without fracture through an angle of not less than 120°, with a curvature at the angle of which the inner radius does not exceed one and a half times the thickness of the sample.

Occasional samples of plates, bulbs, bars, and angles are to be punched and sheared, in accordance with ordinary ship-building practice, and are then to be treated in ordinary ship-yard fashion, under the direction of the surveyor, without failure in any respect.

Angle and tee bars are to be submitted to opening and closing and ram's horn tests, as the surveyor may direct.

Rivet-steel may be of about 28 tons per square inch tensional resistance, and both the material and the manufactured rivets must be subjected to such hot and cold bending and other tests as the surveyor may direct.

In the event of any samples failing in any of the foregoing tests, the plates, bulbs, bars, and angles from which they are taken shall be rejected, and such further tests made as the district chief surveyor may direct, under the circumstances, before any material from the same cast may be accepted.

If desired, the steel may be tested in the presence of the surveyor at the steel-maker's works, in which case invoices in duplicate are to be furnished for certification by the testing surveyor, and every facility is to be afforded him for identification of the plates and bars with the representative test samples and the respective casts from which they have been made. The steel is not to be used at the ship-yard until it has been satisfactorily tested and the invoice, certified by the surveyor, has been produced.

Should any of the material fail in any way in course of being worked into the ship, the surveyor is to be at liberty to submit it to such further tests as the circumstances may dictate, reporting the results to the district chief surveyor, who may reject any defective material, notwithstanding any previous certificate of satisfactory testing.

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"BUREAU VERITAS" RULES FOR 1882.

STEEL VESSELS.

ARTICLE 33, SECTION 1. The scantlings of steel vessels will generally be regulated by the rules for the construction of iron vessels.

SEC. 2. The steel used in the construction of the vessels must comply with the following requirements:

(1) All steel plates, angles, and bulbs to be legibly stamped with a special mark, which shall indicate the guarantee of the manufacturer that the material is of the quality required by the rules. This mark to be so placed that it will be visible on the plate or bar, when riveted up in the ship.

(2) The steel to have an ultimate tensile strength of from 27 to 32 tons per square inch, and an elongation at rupture of at least 20 per cent. on a length of 200 millimeters (7⅞ inches).

(3) Strips about 2 inches wide, cut from the plates, bulbs, and angle bars, after being heated to a dull red and cooled in water at 28° C. (82° F.), shall withstand, without fracture, being doubled over and closed until the width of the opening near the bend is equal to three times the thickness of the sample tested.

SEC. 3. The following reductions may be allowed:

(1) 18 to 25 per cent. on the outside plating, sheer strakes, garboards, water-tight bulkheads, stringers, ties, and keelsons.

(2) 10 to 15 per cent. on the thickness of the floors, bulbs, and angles. These reductions may be greater should the system of construction followed provide a moment equivalent to that exacted in iron vessels.

SEC. 4. The diameter of the rivets, their spacing, and the system of riveting, also the width of laps and butt-straps, should be determined according to the rivets for iron vessels, from the tabular scantlings, and irrespective of the scantlings allowed. The butts of the outside plating to be treble riveted for half the vessel's length amidships, when the number is 200,000 or above, and for two-thirds the length when the number is 300,000 or above.

SEC. 5. Forged iron will be accepted for keel bars, stem, and stern post, for the rudder-head and frame and for pillars.

SEC. 6. A midship section and a longitudinal section, of vessels to be built of steel, shall accompany the request for classification, in order to be submitted for the approval of the Direction.

EXTRACTS FROM SPECIFICATIONS OF RAILROAD BRIDGE OVER THE OHIO RIVER AT HENDERSON, KY.

WROUGHT IRON.

Elastic limit to be not less than 26,000 pounds per square inch.

Iron for tension members, best double-rolled, refined iron, to stand the following tests:

Full-size pieces of flat, round, or square iron, not over 4½ square inches sectional area, shall have an ultimate tensile strength of not less than 50,000 pounds, and shall stretch not less than 12½ per cent. in the whole length.

Bars of more than 4½ square inches sectional area will be allowed a reduction of 1,000 pounds per square inch, for each additional square inch, down to a minimum of 46,000 pounds.

When tested in specimens taken from the above, the ultimate tensile strength shall not be less than 52,000 pounds, with 18 per cent. stretch for bars whose original area was 4½ square inches or less, and for bars whose original area was greater than 4½ square inches, a reduction of 500 pounds for each additional square inch of section will be allowed down to a minimum of 50,000 pounds.

From angle or shape iron, not less than 50,000 pounds, with 15 per cent. stretch in 8 inches.

From plate, not less than 48,000 pounds, with 15 per cent. of stretch.

Iron for tension members must bend cold to 180° to a curve whose inner diameter is 2 thicknesses. Cooled off with ice to 30° F., nicked on both sides, and bent under a sledge, it shall bend and break gradually with uniform fibrous fracture. Specimens from angles, plates, and shape iron shall bend cold to 90° to inner diameter of not more than 3 thicknesses.

STEEL.

To be manufactured by the open-hearth process. Bessemer steel will not be accepted.

A small ingot shall be cast from every charge, and a sample bar, ¾-inch, rolled from it. If this bar fails to meet requirements of laboratory tests the whole charge shall be rejected.

Ingots of each cast, and blooms and finished pieces, shall be marked with the number of the cast.

Steel used in compression members, bearing plates, pins, and rollers shall contain not less than .34 per cent. nor greater than .42 per cent. carbon, and not more than .10 per cent. of phosphorus.

A sample bar, ¾-inch in diameter, shall bend to 180° around its own diameter.

The same bar in a lever machine shall show an elastic limit of not less than 50,000 pounds, and an ultimate tensile strength of not less than 80,000 pounds, with an elongation of 15 per cent. in 8 inches, and a reduction of area of at least 30 per cent. at fracture. Shall be incapable of tempering.

Steel for rivets and eye-bars shall contain not more than .26 per cent. carbon and less than .10 per cent. phosphorus. A ¾-inch round bar shall close to 180°, and in a lever machine shall have an elastic limit of not less than 40,000 pounds, and an ultimate tensile strength of not less than 70,000 pounds, with an elongation of not less than 20 per cent. in 8 inches, and a reduction of area of not less than 40 per cent. at fracture. In full-size bars, this steel shall show an elastic limit of not less than 36,500 pounds, and an ultimate tensile strength of not less than 66,000 pounds, with an elongation of not less than 10 per cent., and for strains greater than 30,000 pounds shall have modulus of elasticity of from 28,000,000 to 30,000,000.

All plates to be rolled in a universal mill.

Steel for pins shall not be hammered, but rolled in Gothic rolls.

Riveted steel work.—The holes shall be punched enough smaller than the diameter required for the rivet to admit of $\frac{1}{16}$-inch riming all around after assembling. Sharp edges of round hole to be trimmed to a slight fillet under rivet heads, and the piece riveted together without being taken apart. All rivets in steel members will be of steel.

Annealing.—After working, eye-bars shall be annealed by heating them to a uniform dull red heat and allowing to cool slowly.

Friction rollers.—Wrought iron—pressure in pounds per linear inch of rollers shall not exceed $\sqrt{540000 \times d}$, where d = diameter of roller in inches. For steel rollers an addition of 25 per cent. may be made to the above pressures.

Pitch of rivets.—In compression members, from center to center not more than 6 inches, or 16 times the thickness of any of the joined plates, and for a distance of two

than 4 diameters of rivet.

Distance between edge of any piece and center of rivet hole must not be l
$1\frac{1}{4}$ inches except in bars less than $2\frac{1}{2}$ inches wide; where practicable it sh
least 2 diameters of rivet.

Pin strains.—For shearing not greater than 7,000 pounds for wrought iron,
pounds for steel. Maximum fiber strain from bending shall not be greater th
pounds for wrought iron, or 20,000 for steel.

Bearing strain on area = diameter by thickness of head, shall be not grea
12,000 pounds for wrought iron or 18,000 for steel.

Rivets.—Shearing stress not greater than 7,000 pounds for wrought iron
pounds for steel; bearing strain 10,000 pounds for wrought iron and 15,000 p
steel, for all rivets in bearing and splice plates; elsewhere 12,000 pounds for
18,000 for steel.

Combined strains.—In members subjected to combined compression and tensil
the maximum compressive stress shall be not greater than 7,000 pounds p
inch.

Tensile strains.—For wrought iron tension members and rolled beams 10,00
Bottom flanges of riveted girders 8,000 pounds net section.

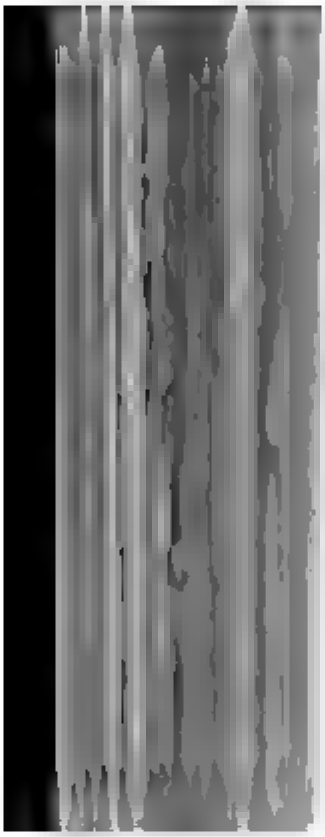
Steel tension members 14,000 pounds.

Compressive strains.—In steel compression members up to 16 diameters i
14,000 pounds. For a greater ratio, $\frac{11}{8}$ths of the results for wrought iron as g
table accompanying.

Factor of safety, 5.

CONTENTS OF THE ANNUAL REPORT OF THE SECRETARY OF THE NAVY, 1885.

LIST OF PAPERS ACCOMPANYING VOLUME I, REPORT OF THE SECRETARY OF THE NAVY, 1885.



INDEX TO APPENDIX.